Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
2015		**00-00-2015 to 00-00-2015**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Air Transport Pilot Supply and Demand: Current State and Effects of Recent Legislation	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **RAND Corporation,1776 Main Street, P.O. Box 2138,Santa Monica,CA,90407-2138**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

Many airline industry experts have recently predicted crippling shortages in the supply of Airline Transport Pilots. The main reasons for concern in the United States over pilot shortages arises from recent legislation stemming from the 2009 Colgan air crash, an impending wave of mandatory retirements, a decreasing supply of new professional pilots into the pipeline, and major airline expansion. This study provides a comprehensive Airline Transport Pilot (ATP) supply and demand model and then assesses the current and future ATP supply and demand pipeline, to include the impact on the U.S. military pilot population. Subsequently, it evaluates policy options available to government, industry, and the military to mitigate any potential shortfalls in the future supply chain. This study finds there will not be a civilian system-wide pilot shortage in the near-term though the system will become strained. Low-paying airlines will continue to have difficulties finding qualified pilots. All operators will experience fewer applicants for the available positions, potentially resulting in less qualified pilots system-wide. Barring any policy changes the military will experience an inventory shortage in the near-term.

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**177**	

This product is part of the Pardee RAND Graduate School (PRGS) dissertation series. PRGS dissertations are produced by graduate fellows of the Pardee RAND Graduate School, the world's leading producer of Ph.D.'s in policy analysis. The dissertation has been supervised, reviewed, and approved by the graduate fellow's faculty committee.

Dissertation

Air Transport Pilot Supply and Demand

Current State and Effects of Recent Legislation

Michael McGee

RAND CORPORATION

Dissertation

Air Transport Pilot Supply and Demand

Current State and Effects of Recent Legislation

Michael McGee

This document was submitted as a dissertation in March 2015 in partial fulfillment of the requirements of the doctoral degree in public policy analysis at the Pardee RAND Graduate School. The faculty committee that supervised and approved the dissertation consisted of Dr. Al Robbert (Chair), Dr. Ray Conley, and Dr. Suzanne Buono.

PARDEE RAND GRADUATE SCHOOL

The Pardee RAND Graduate School dissertation series reproduces dissertations that have been approved by the student's dissertation committee.

The RAND Corporation is a nonprofit institution that helps improve policy and decisionmaking through research and analysis. RAND's publications do not necessarily reflect the opinions of its research clients and sponsors.

Published 2015 by the RAND Corporation
1776 Main Street, P.O. Box 2138, Santa Monica, CA 90407-2138
1200 South Hayes Street, Arlington, VA 22202-5050
4570 Fifth Avenue, Suite 600, Pittsburgh, PA 15213-2665
RAND URL: http://www.rand.org/
To order RAND documents or to obtain additional information, contact
Distribution Services: Telephone: (310) 451-7002;
Fax: (310) 451-6915; Email: order@rand.org

Abstract

Many airline industry experts have recently predicted crippling shortages in the supply of Airline Transport Pilots. The main reasons for concern in the United States over pilot shortages arises from recent legislation stemming from the 2009 Colgan air crash, an impending wave of mandatory retirements, a decreasing supply of new professional pilots into the pipeline, and major airline expansion.

This study provides a comprehensive Airline Transport Pilot (ATP) supply and demand model and then assesses the current and future ATP supply and demand pipeline, to include the impact on the U.S. military pilot population. Subsequently, it evaluates policy options available to government, industry, and the military to mitigate any potential shortfalls in the future supply chain.

This study finds there will not be a civilian system-wide pilot shortage in the near-term, though the system will become strained. Low-paying airlines will continue to have difficulties finding qualified pilots. All operators will experience fewer applicants for the available positions, potentially resulting in less qualified pilots system-wide. Barring any policy changes, the military will experience an inventory shortage in the near-term.

Table of Contents

Figures

Tables

Summary

Many airline industry experts have recently predicted crippling shortages in the supply of Airline Transport Pilots. The main reasons for concern in the United States over pilot shortages arises from recent legislation stemming from the 2009 Colgan air crash[1], an impending wave of mandatory retirements, a decreasing supply of new professional pilots in the pipeline, and major airline expansion.

This study provides a comprehensive Airline Transport Pilot (ATP) supply and demand model and then assesses the current and future ATP supply-and-demand pipeline. This pipeline runs from civilian pilot training, through commercial, charter, corporate, fractional, and regional airline operators, to the major airlines. This study also evaluates the effect of civilian pilot hiring on the U.S. military pilot population. Subsequently, it evaluates policy options available to government, industry, and the military to mitigate any potential shortfalls in the future supply of pilots.

This study finds that a civilian system-wide pilot shortage will not occur in the near-term, though the system will struggle to produce the number of pilots needed. The most important change in the pipeline will be a significant, long-term hiring increase at the major airlines. The duration of this hiring increase will be unprecedented in the U.S. aviation industry. The effects of this hiring increase will propagate through the entire pipeline, affecting both the civilian and the military flows.

On the civilian side, low-paying airlines will continue to have difficulties finding qualified pilots. All civilian operators will experience fewer applicants for the available positions, potentially resulting in less qualified pilots system-wide. This decrease in qualification could manifest itself in increased safety issues, a primary concern for the FAA, individual operators, and the travelling public. Many policy options are available to increase the civilian pilot supply, thus decreasing the long-term strain on the pilot pipeline.

The military will experience an increase in losses as major airline hiring increases, and pilot inventories will fall below pilot requirements. This shortfall will affect the U.S. Navy fixed-wing pilot population first, then the USAF pilot population. The USAF is shielded from these near-term effects because its requirements decrease over the next two years. Barring any major policy changes, the USN will experience a 10 percent pilot shortfall by 2020, and the USAF will experience a 1000 pilot shortfall by 2022. Policy options are available to the military services to ameliorate these shortfalls.

[1] The crash of Colgan Air Flight 3407 involved a regional airline, and a subsequent investigation by the National Transportation Safety Board attributed the cause of the crash to pilot error. Subsequent legislation tightened requirements.

Acknowledgments

I wish to extend thanks to my dissertation committee, Dr. Al Robbert (Chair), Dr. Ray Conley, and Dr. Suzanne Buono. I would also like to extend appreciation to the those who provided critical assistance to this effort: Dr. Jim Bigelow, John Allen (FAA), Andrew Von Ah (GAO), Tom Hiltner (FAPA), Captain Jim Mangie (Delta), Captain Mark Champion and Captain John Weigand (United), Captain Darren Greubel (ExpressJet), Captain Carlos Zendejas (Alaska), Laura Guay, Lt Col Robert Foster (USAF), Lt Col Edward Ellis (USAF), CDR Kevin Boardman (USN), and Captain Robert Raskey. I would also like to thank RAND Project Air Force and the USAF for funding this effort.

Abbreviations

AABI	Aviation Accreditation Board International
ACCP	Aviation Career Continuation Pay
ACIP	Aviation Career Incentive Pay
ALPA	Air Line Pilots Association
ANPRM	Advance Notice of Proposed Rulemaking
AOPA	Aircraft Owners and Pilots Association
ARC	Aviation Rulemaking Committee
ATP	airline transport pilot
ATP CTP	Airline Transport Pilot Certification Training Program
BL	blue line
CAPA	Coalition of Airline Pilots Associations
CFI	Certified Flight Instructor
CFT	Cost of flying training
CRM	Crew Resource Management
EASA	European Aviation Safety Agency
EIS	Enforcement Information System
FAA	Federal Aviation Administration
FFS	full flight simulator
FITS	FAA Industry Training Standards
FO	first officer, same as SIC
FOQ ARC	FO Qualifications Aviation Rulemaking Committee
FSTD	flight simulation training device
FT/DT	flight time/duty time
FTD	flight training device
IFALPA	International Federation of Air Line Pilots' Associations
IATA	International Air Transport Association

ICAO	International Civil Aviation Organization
IOE	Initial operating experience
MPL	Multi Crew Pilot License
NASA	National Aeronautics and Space Administration
NPRM	Notice of Proposed Rulemaking
NTSB	National Transportation Safety Board
PIC	pilot in command (captain)
R-ATP	restricted privileges airline transport pilot
RL	red line
SARP	Standards and Recommended Practices
SIC	second in command, same as first officer
SSP	Streamlined selection procedure
TEM	Threat and Error Management
UAA	University Aviation Association
UPRT	Upset Prevention and Recovery Training
USERRA	Uniformed Services Employment and Reemployment Rights Act

1. Introduction

Many airline industry experts have recently predicted crippling shortages in the supply of airline transport pilots (ATPs). The main reasons for concern in the United States (U.S.) over pilot shortages arise from recent legislation stemming from the 2009 Colgan air crash, an impending wave of mandatory retirements, a decreasing supply of new professional pilots into the pipeline, and forecasts of continuing expansion of the major airlines. A Wall Street Journal article stated, "US airlines are facing what threatens to be their most serious pilot shortage since the 1960s" (Carey, Nicas et al. 2012). Mr. John Allen, the Director of Standards for the Federal Aviation Administration (FAA), called this potential problem "astounding and dramatic," and added, "We don't have a system to address this issue" (Carey, Nicas et al. 2012). During a February 26, 2015, budget hearing in Congress Department of Transportation Secretary Foxx stated, "There are more restrictive flight and duty time regulations and increased training requirements for first officers that went into effect January 2014. Those changes have led to a significant shortage in pilots."[2] This potential problem is not limited to the United States. A study commissioned by Boeing stated, "A pilot shortage has already arisen in many regions of the world" (Davis 2012).

The main reason for concern in the United States over pilot shortages cited in most studies stems from the anticipated effects of recent legislation, Public Law 111-216, the *Airline Safety and Federal Aviation Administration (FAA) Extension Act of 2010*. This legislation covered a wide range of safety and training initiatives, among them 1) directing the FAA to ensure "flight crewmembers have proper qualifications and experience" and 2) directing the FAA "to specify limitations on the hours of flight and duty time allowed for pilots" (USG 2010). In response to this legislation, the FAA has implemented two new rules for pilots involved in air carrier operations.[3]

The first rule, *Pilot Certification and Qualification Requirements for Air Carrier Operations*, now requires all pilots participating in air carrier operations to hold at least a restricted airline transport pilot (R-ATP) certification. This rule effectively increases the flight time minimums for airline new hires from approximately 250 hours[4] to 1500 hours.[5] A summary of the new limits is shown in Table 1. This increase in flight hour minimums took effect in August 2013.

[2] https://www.codot.gov/news/dailyclips/march-2015-clips/march-6-2015

[3] Air carrier operations include regional airlines (e.g., SkyWest), major airlines (e.g., United Airlines), and large cargo carriers (e.g., FEDEX).

[4] Approximate average time it takes to achieve the old requirement: commercial pilots license with instrument and multi-engine rating.

Table 1.1. First Officer Qualification Rules

Qualifications	Prior Rules	New Rules
Airline transport pilot (ATP) certificate Multi-engine airplane	• At least 23 years old • Hold commercial pilot certificate with instrument rating • Pass ATP knowledge and practical tests • 1,500 hours total time as pilot	• Meet all requirements in prior rules • Have at least 50 hours in a multi-engine airplane • Successfully complete new ATP Certification Training Program prior to taking the ATP knowledge test
ATP certificate with restricted privileges (multiengine airplane rating only)	None	• At least 21 years old • Hold commercial pilot certificate with instrument rating • Successfully complete new ATP Certification Training Program prior to taking the ATP knowledge test (after July 31, 2014) • Pass ATP knowledge and practical tests • At least 750 hours total time as a military pilot or • At least 1,000 hours total time as pilot and a Bachelor's degree with an aviation major or • At least 1,250 hours total time as pilot and an Associate's degree with an aviation major or • 1,500 total time as a pilot.
Serve as first officer (co-pilot) in Part 121 air carrier operations	• Hold commercial pilot certificate with instrument rating • At least a second-class medical certificate	• ATP certificate with type rating for aircraft flown or • ATP certificate with restricted privileges and type rating for aircraft flown • At least a second class medical certificate
Serve as captain (pilot in command) in Part 121 air carrier operations	• ATP certificate with type rating for aircraft flown; • At least 1,500 hours total time as pilot • First class medical certificate	• Meet all requirements in prior rules • At least 1,000 flight hours in air carrier operations (as co-pilot in Part 121 operations, as captain in fractional ownership operations, as captain in Part 135 turbojet, commuter, or 10 or more passenger seat operations, or any combination thereof)

SOURCE: (FAA 2013)

As a result of this rule, all pilots participating in the following operations are required to hold an ATP or restricted (R-ATP) certificate:

[5] The 1500-hour minimum is reduced by 500 hours for pilots who received their pilot training at an accredited four-year undergraduate institution, 250 hours for pilots who received their pilot training at an accredited two-year undergraduate institution, and is reduced by 750 hours for pilots who received their training from the U.S. military.

- In Part 121[6] operations, each pilot in command (PIC) and each second in command (SIC)
- In Part 135[7] operations, each PIC if they are operating in (FAA 2013):
  - commuter operations using multiengine airplanes with nine or less passenger seats
  - on-demand operations using multiengine airplanes with ten or more passenger seats
  - turbojets
- In Part 91K[8] operations, each PICs of multiengine turbine-powered fixed-wing airplanes

The rule also requires an ATP Certification Training Program (CTP) before obtaining an ATP certificate. This program "includes training in: aerodynamics, automation, adverse weather conditions, air carrier operations, transport airplane performance, professionalism, and leadership and development. The training program will impart conceptual knowledge through educational courses and reinforce that knowledge through training in a flight simulation training device (FSTD)" (FAA 2013). Part 121 air carriers, Part 135 operators, Part 142 training centers, or Part 141 pilot schools can give this training once approved by the FAA. This training includes 30 hours of academic training and ten hours of simulator training. At least six of the ten simulator hours of training must be completed in a full-flight simulator (FFS), Level C[9] or higher. This additional training currently costs approximately $5,000[10] per pilot.

The second rule, *Flightcrew Member Duty and Rest Requirements,* places new limits on the number of flight hours, work hours, and rest required for pilots involved in air carrier operations. Previously the rules governing flight time and duty time were part of the regulation governing Air Carriers, Federal Aviation Regulation (FAR) Part 121 (FAA 2013). The new rules make up a new FAR, Part 117. A summary of the new limits is shown in Table 1.2. This rule took effect in January 2014.

[6] Federal Aviation Regulation, Title 14, Part 121 governs airline operations.

[7] Federal Aviation Regulation, Title 14, Part 135 governs charter and air-taxi operations.

[8] Federal Aviation Regulation, Title 14, Part 91K governs fractional operations.

[9] Level C FFS requires a motion platform with all six degrees of freedom. It also requires lower latency over levels A & B. The visual system must have an outside-world horizontal field of view of at least 75 degrees for each pilot. 14 CFR Part 60, Appendices B and D.

[10] http://www.atpflightschool.com/atp/ctp/

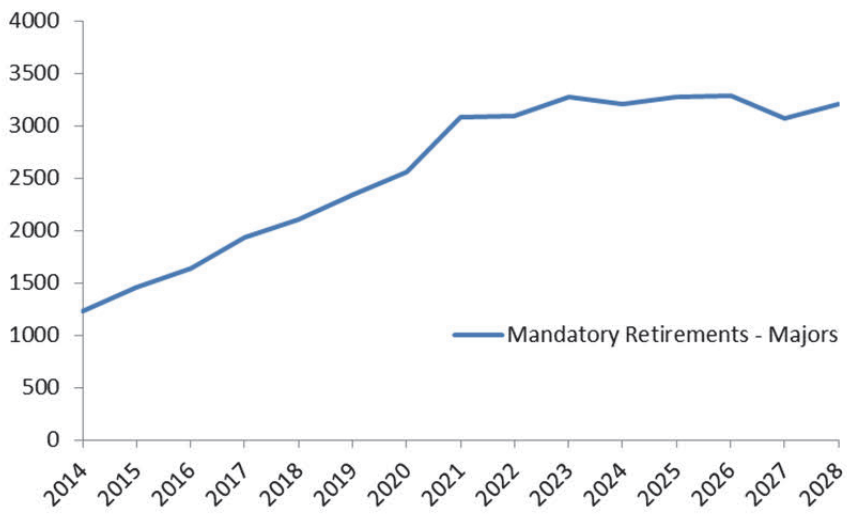
Table 1.2. Flight Time/Duty Time (FT/DT) Rules

Scenario	Rest time		Duty time		Flight time	
	Minimum rest prior to duty domestic	Minimum rest prior to duty international	Maximum flight duty time unaugmented[11]	Maximum flight duty time augmented[12]	Maximum flight time unaugmented	Maximum flight time augmented
Old Part 121	Daily: 8-11 hours depending on flight time	Minimum of 8 hours to twice the number of hours flown	16 hours	16-20 hours depending on crew size	8 hours	8-16 hours depending on crew size.
New Part 121	9 hours	9 hours	9-14 hours depending on start time and number of flight segments	12-18 hours depending on start time, crew size, and aircraft rest facility	8-9 hours depending on flight duty period start time	None

SOURCE: (FAA 2013)

Along with the concern for the effect of these new rules, many studies have pointed to three other factors that may help to create a future shortage. The first factor is an upcoming wave of mandatory retirements among pilots in the major airlines. As Figure 1.1 shows, mandatory age retirements from the major airlines started accelerating in 2014 and continue to do so until they peak at over three thousand per year in 2021, and they remain at that level through 2028.

Figure 1.1. Age 65 Mandatory Retirements - Majors



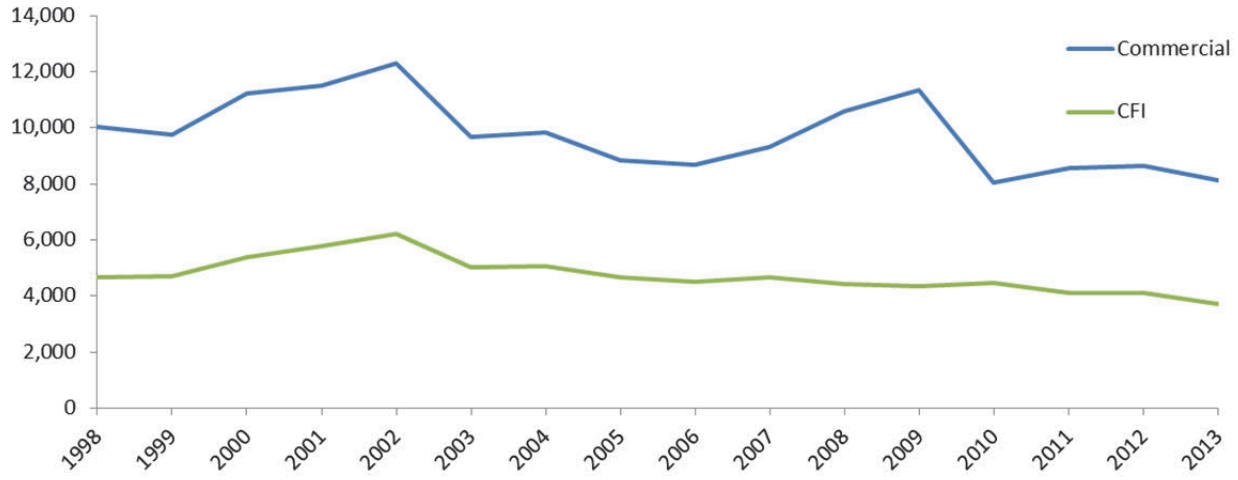
SOURCE: PF Model

[11] Unaugmented means there are no other flight crews on the flight

[12] Augmented means there are other flight crew on the flight that will fly for a portion of the flight, allowing crews time to rest

The second factor is a decreasing supply of new professional pilots into the pipeline. As figure 1.2 shows, there is a long-term decrease of both new commercial pilots and certified flight instructors (CFI), the pilot pool that will make up the majority of future airline pilots.

Figure 1.2. FAA Original Certifications Issued



SOURCE: FAA[13]

New commercial pilot production is down from 10042 in 1998 to 8140 in 2013. New CFI pilot production is down from 4647 in 1998 to 3723 in 2013. There are many reasons for this decrease in production, mostly connected to a decreased demand of airline pilots. This decreased demand lasted for a decade from 2002-2012. The four main causes of this stagnation in demand were the industry slowdown after the 9/11 attack, the major airline bankruptcies and consolidations, the 2008/2009 recession, and the lack of retirements after the 2007 mandatory age requirement relaxation from age 60 to age 65.

The last factor many studies point to as a cause of future pilot shortages is forecasts of continuing expansion of the major airlines. The 2014 Boeing Current Market Outlook 2014–2033 forecasts 7550 new airliners in the United States and a demand for 88000 new pilots in North America during the forecast period (Boeing 2014).

Before August 2013, pilots holding a commercial certificate with instrument rating could seek employment in the roles and organizations indicated below:

- As a flight instructor, if they also gained a CFI rating
- With a commercial operation, typically to build time until they were more competitive to apply for a regional airline
- With a regional airline

[13] https://www.faa.gov/data_research/aviation_data_statistics/civil_airmen_statistics/

As of August 2013, pilots can no longer apply for employment with a regional airline until they have gained an at least an R-ATP certificate. The FAA's new certification for pilots in air carrier operations requires the following (FAA 2012):

- A second in command (first officer) in part 121 operations to hold an airline transport pilot (ATP) certificate and a type rating for the aircraft to be flown
- Pilots with an aviation degree or military pilot experience and fewer than 1,500 hours total time as a pilot to obtain an ATP certificate with restricted privileges
- At least 1,000 flight hours in air carrier operations to serve as a pilot-in-command in part 121 air carrier operations.
- 50 hours of multi-engine flight experience and completion of a new FAA-approved ATP Certification Training Program for a Multiengine Class Rating or Type Rating that would include academic training and training in a flight simulation-training device.

The looming question is whether the deletion of the employment path for pilots with commercial certificates and with instrument ratings to the regional airlines, along with new restrictions for flight and duty time, coupled with the bow wave of airline pilots who will retire in the next 15 years, a decrease in new pilots entering the system, and major airline growth will create a workforce gap. There are a restricted number of positions in commercial operations and instructional operations for all these pilots to fill. If this workforce gap occurs, how will pilots effectively and economically gain the extra flight time required to open the opportunity for regional airline employment and subsequent major airline employment?

Organization

This dissertation is organized into eight chapters. This chapter serves as an introduction to the topic, provides a background of the important terms and issues, and lays out the methodology used in this dissertation. Chapter Two includes the literature reviews of previous studies on this issue, and summarizes previous findings. Chapter Three covers the pilot demand for the specific nodes of the U.S. pilot pipeline. Chapter Four covers the pilot supply for the specific nodes of the U.S. pilot pipeline. Chapter Five integrates the results of the previous two chapters and discusses near-term U.S. pilot pipeline expectations based on these data. Chapter Six discusses policy options available to the industry, government, and the military as they relate to the model results and near-term pipeline expectations. Chapter Seven lists the policy recommendations for the industry, government, and the military based on the preceding discussion. Finally, Chapter Eight discusses issues for further consideration, to include areas for future study.

Primary Aim

This dissertation follows a manuscript format with the following primary aims:

1. Build a U.S. pilot flow (PF) model, including modeling of recent legislative changes.

2. Analyze and assess validity of extant predictions regarding an impending pilot shortfall.
3. Identify policy options to government and industry to mitigate any potential shortfalls in the future supply chain.

Problem Significance

Although many studies have investigated pilot manning within the military and within the Part 121 airline industry, there is a lack of research on the entire pilot manning structure within the United States and globally. A shortage of the U.S. pilot supply, or available stock, could have significant effect on a number of issues, including route limitations, economic viability for certain airlines, economic effect on cargo and the travelling public, and stress on military pilot manning.

The civil air transport industry is a critical fixture of the US economy. A 2011 report by the Department of Transportation examined the national impact of this industry. Study authors found the following about civil aviation in 2009:

- accounted for 5.2 percent of the US gross domestic product (GDP)
- produced $1.3 trillion in related goods and services
- generated 10 million jobs
- generated earnings of $394 billion.

The study notes, "The industry contributes positively to the US trade balance, creates high-paying jobs, helps keep just-in-time business models viable, and connects us to friends, family and commercial opportunities"(FAA 2011). A significant pilot shortage would deliver an economic shock to the civil air transport industry. This shock would reverberate throughout the overall U.S. economy.

Important Terms

This discussion requires a basic understanding of the airline industry. This section defines only the types of pilot positions, certificates, ratings, and operations relevant to the ATP shortage discussion.

Federal Aviation Regulations (FAR)

The following are the Federal Aviation Regulations applicable to this discussion and the operations they govern:

- Part 61 – governs certification for private pilots, flight instructors, and ground instructors.
- Part 141 – similar to Part 61 in that it covers pilot training, but also covers an FAA-approved structured method for pilot training, based on an FAA syllabus and other standards.
- Part 91 – covers the general operating rules for all aircraft.
- Part 91 Subpart K (Part 91K) – covers fractional ownership programs.

- Part 117 – a new regulation that covers flight time and duty time limitations and rest requirements for flight crewmembers (in effect since January 2014).
- Part 121 – covers scheduled air transport operations. These include major airlines (e.g., United Airlines), large cargo carriers (e.g., FEDEX), and regional airlines (e.g., ExpressJet). It also covers other operations offering common carriage with aircraft containing greater than 30 seats or over 7500 pounds of cargo capacity, also called Supplemental,
- Part 125 – covers operation of aircraft having a seating capacity of 20 or more passengers or a payload capacity greater than 6000 pounds, and not used in common carriage (e.g., a corporate-owned Boeing 737).
- Part 135 – covers commuter and on-demand operations for aircraft with 30 seats or less.[14]
- Part 137 – covers agricultural aircraft operations.
- Part 142 – covers the certification and operation of aviation (ground/simulator) training centers.

Pilot Categories

The two categories of pilots discussed in this study are as listed below:

- Pilot-in-command (PIC) – interchangeable with the term captain in this study. The pilot ultimately responsible for the safe operation of the aircraft, the safety of any passengers, and for ensuring all operations complies with applicable federal and international regulations. A single pilot in a Cessna 172 airplane is the pilot-in command. The pilot in the left seat of a Boeing 747 aircraft with 400 passengers is the pilot-in-command (or captain).
- Second-in-command (SIC) - interchangeable with the term first officer (FO) in this study. The second-in-command of any aircraft. In single-pilot operations, there is no first officer.

Relevant Pilot Certificates

While there are many types of pilot certificates in the United States, this study focuses on the following types of pilots:

- Student Pilot – An individual who is learning to fly and has passed a third-class medical examination. A student pilot can fly solo once endorsed by a certified flight instructor (CFI), but cannot carry passengers.
- Private pilot – A certified pilot who can carry passengers for pleasure or business, but not for compensation. This certificate requires a second-class medical certificate.
- Instructor pilot – Called a certified flight instructor, these pilots instruct other pilots. CFIs can instruct from student pilots up to and including commercial pilots, as individually authorized.
- Commercial pilot – A pilot certified to carry passengers for compensation. This certificate also requires a second-class medical certificate. Prior to August 2013, this was

[14] There are other restrictions to this FAR based on non-transport category turbo-propeller powered airplanes but those details are inconsequential to this discussion.

the minimum required certification[15] for those pilots flying as second-in-command. Most graduates from 4-year undergraduate universities with flight programs graduate with a commercial certificate with instrument rating. Military pilots who graduate from military pilot training automatically receive this FAA certificate with instrument rating if they apply for it. Military pilots who separate after their 10-year post-pilot training commitment also qualify for at least an R-ATP certificate after minimal additional training.

- Airline transport pilot (ATP) – A pilot certified to operate as PIC[16] of an aircraft involved in airline operations, and certain Part 135 and Part 91(K) operations. Minimum basic requirements are 1,500 hours flight time and 500 hours cross-country time.
- ATP certificate with restricted privileges (R-ATP) – New certificate, will allow pilots with a two-year aviation degree with an associated Part 141 operation to gain an ATP certificate with a minimum of 1,250 hours; will allow pilots with a 4-year aviation degree with an associated Part 141 operation to gain an ATP certificate with a minimum of 1,000 hours; and will allow a pilot with military pilot experience (defined as having graduated from military pilot training) to obtain an ATP with a minimum of 750 hours.
- Military pilot – A pilot in the U.S. military, in the Army, the Air Force, the Navy, or the Coast Guard.

Relevant Pilot Ratings

A rating is an addition to a certificate. While there are many types of pilot ratings in the United States, this study focuses on the following:

- Instrument rating – This rating allows pilots to fly aircraft in instrument meteorological conditions (IMC). IMC refers to poor weather, generally defined as conditions in which visibility is less than three nautical miles and cloud cover is less than 1,500 feet above the ground. ATP certificates automatically include an instrument rating.
- Multi-engine rating – This rating allows pilots to fly multi-engine aircraft.
- Type rating – This allows pilots to fly a specific type of aircraft, and applies to larger aircraft such as the Boeing 737. In addition, ATP pilots can instruct other pilots in the aircraft in which they have a type rating.

Classifications of Medical Certificates

There are three types of relevant medical certificates:

- Third class – required for private pilot certificates.
- Second class – required for commercial pilot certificates and Part 121 SIC not requiring a first class certificate. For this category, a new examination is generally required every 12 months.
- First class – required for Part 121 PIC, Part 121 SIC when the flight requires three or more pilots, and Part 121 PIC/SIC at or over 60 years of age. For this category, a new

[15] An instrument rating is also required for a pilot to operate as pilot-in-command for commercial operations.

[16] Also known as the captain.

examination is required every 12 months under age 40, and every 6 months at age 40 or above.

Airline Classifications as Employed in this Study

For this study, determination was made as to which Part 121 operators to include in the major airline category and which to include in the minor airline category. Part 121 establishes the operational rules for air carriers flying for compensation or hire. The FAA uses three basic categories for Part 121 carriers, Flag, Domestic, and Supplemental.

- A flag operation includes "any scheduled operation (operating in Alaska or Hawaii to any point outside of those states, or to any territory or possession of the United States, or from any point outside the United States to any point outside the United States) being conducted with either a turbo-jet aircraft, an airplane having ten or more passenger seats, or a payload capacity greater than 7,500 pounds"(FAA 2011).
- A domestic operation is "any scheduled operation (within the 48 contiguous states, the District of Columbia, or any territory or possession) being conducted with either a turbo-jet aircraft, an airplane having ten or more passenger seats, or a payload capacity greater than 7,500 pounds"(FAA 2011).
- A supplemental operation is "any common-carriage operation conducted with airplanes having more than 30 passenger seats, or with a payload capacity of more than 7,500 pounds"(FAA 2011).

The problem with using these definitions is they do not categorize those airlines where a professional pilot would most likely stay for the majority of his/her career. While there are no clear-cut definitions, the following distinctions were used to classify the 82 different Part 121 carriers in the United States.

- Major – flag, domestic, supplemental, or any combination thereof, with a maximum pay scale above $150/hr., retirement plan, flying aircraft Boeing 737/Airbus 320 or larger. Additionally, the operator's average pilot salaries are over $100,000 as determined by Department of Transportation Schedules P-5.2 and P-10.
- Minor – all others.

The complete listing of U.S. air carriers and their specific classifications can be found in Appendix B.

Background

In 2009, the minimum requirement for a pilot to fly as a first officer in any Part 121 operation was a commercial pilot certification with an instrument rating. The standard flow of pilots from initial pilot training to major airlines is the same today as it was in 2009, and is represented in the pilot flow model depicted at Figure 1.3. Regional airlines typically hired qualified applicants as first officers with certifications as low as commercial pilot with instrument rating, though because of applicant competition, most airlines hired applicants with well over 500 hours. Major airlines, as a result of their relatively higher wages and better

benefits, typically hired ATP-certified regional captains and military pilots who separated from the service when their commitment ended.[17] As a baseline, first officers gained their experience at the regional airlines, earning an ATP certification in the process, and then applied for a position at a major passenger or cargo air carrier.

On February 12, 2009, a Colgon Air flight, operating as Continental Connection Flight 3407, crashed near Clarence Center, New York. Both pilots, two flight attendants, and all 45 passengers aboard the airplane were killed. The FAA determined the probable cause of the accident was (NTSB 2010) as indicated below:

> The captain's inappropriate response to the activation of the stick shaker, which led to an aerodynamic stall from which the airplane did not recover. Contributing to the accident was:
>
> (1) the flight crew's failure to monitor airspeed in relation to the rising position of the low-speed cue
> (2) the flight crew's failure to adhere to sterile cockpit procedures
> (3) the captain's failure to effectively manage the flight
> (4) Colgon Air's inadequate procedures for airspeed selection and management during approaches in icing conditions.

As a result, the FAA recommended 25 new changes and reiterated three previously recommended changes to existing Federal Codes, FARs, and guidance.

The families of those who perished on Flight 3407 effectively organized to ensure these recommendations translated into legislation. They specifically advocated for changes in the following areas (FOCF 2013):

- flight and duty time
- safety management systems
- crew member training
- crew member screening/qualifications
- ATP certificate requirement
- mentoring/professional development/leadership
- stall/upset recognition and recovery
- remedial training programs

Because of this accident, Congress passed the Airline Safety and Federal Aviation Administration Extension Act of 2010. In response to this Act, the FAA implemented two new rules, the *Pilot Certification and Qualification Requirements for Air Carrier Operations* and the *Flightcrew Member Duty and Rest Requirements*. These two new rules raised the concern about an upcoming pilot shortage environment.

[17] Military commitment post-pilot training in recent years is 10 years after graduation from pilot training. This commitment generally equates to 1000-1500 hours for fighter pilots and over 2000 hours for transport and bomber pilots.

Research Questions

This dissertation focuses on the following research questions:

1. What effects will recent legislative changes, imminent retirements, and future industry growth have on the supply and demand of ATPs?
2. What policy options are available to mitigate the potential for future ATP shortages?

Sources of Data

The research aimed to use data that met the following two criteria: 1) recognized within the industry as trustworthy, and 2) from sources with no direct benefit from either a shortage or a glut. These two criteria, especially #2, narrowed the potential sources significantly. The institutions and businesses with the most to gain or lose are the publishers of the majority of the studies on this subject thus far.

The following sources of data were used to build and run the model

- FAA
  - Aviation Forecast FY 2014-2034

    This study used the FAA Aerospace Forecast FY 2014-2034 as the baseline for the fleet growth at the majors. This study is published annually and not only includes the forecasts, but also publishes its historical accuracy. This study chose to use the FAA forecast because of its deep knowledge of the industry, historical record, and significant resources.
  - Air Taxi and General Aviation Surveys

    This was used in conjunction with the above forecast to parse out the Part 135, 137, 125, 91, and 91K subgroups and their future forecast growth or contraction. The survey includes all "civil aircraft registered with the FAA that are based in the US or US territories and that were in existence, potentially active between January 1 and December 31, 2012, and had a valid registration"(FAA 2012). This includes aircraft operating under:
    - Part 91: General operating and flight rules
    - Part 91(K): Fractional ownership
    - Part 125: Certification and operations: Airplanes having a seating capacity of 20 or more passengers or a maximum payload capacity of 6,000 pounds or more (but not for hire)
    - Part 133: Rotorcraft external load operations
    - Part 135: On-demand (air taxi) and commuter operations not covered by Part 121
    - Part 137: Agricultural aircraft operations

- FAA Air Operator Information Table

  This database contains information on every operating certificate in the United States, including every Part 91, Part 91K, Part 121, Part 125, Part 129, Part 133, Part 135, Part 137, and Part 121/135 operation. The data include 104 different data fields for each operator, including information on its pilots and types, the types of operations it conducts, and their certification dates. This database is formed from required reporting from all operators to the FAA through the Flight Standards Automation System.

- FAA Air Operator Aircraft Table

  This database contains aircraft information for every operator certificate in the U.S., including every Part 91, Part 91K, Part 121, Part 125, Part 129, Part 133, Part 135, Part 137, and Part 121/135 operation. The data includes 18 different data fields for each operator, including information on their aircraft types, numbers of each type, and their certification dates. This database is formed from required reporting from all operators to the FAA through the Flight Standards Automation System.

  These two files were used to build the model baseline for Part 91, Part 91K, Part 121, Part 125, Part 129, Part 133, Part 135, Part 137, and Part 121/135 operators in the United States. These files were also used to determine specific airline fleet makeup between wide body and narrow body aircraft.

- FAA Certificated Pilot Schools - 141 specific information

  This database contains aircraft information for every Part 141 flight school in the United States. The data include 193 different data fields for each school, including information on their instructors, their average enrollment, aircraft types, numbers of each type, types of certifications they offer, and their certification dates. This data, in combination with the Air Taxi and General Aviation Surveys database was used to build the model baseline for active Part 141 and Part 61 training operators in the United States.

- Airmen Certification Releasable Database

  This database contains two relevant files. The Pilot_Basic database contains individual information for every pilot licensed in the United States[18]. The data include 13 different fields for each pilot, including address, class of medical examination, and examination date. Second, the Pilot_Cert database contains

[18] Pilots can request that their individual information be removed from this releasable database. Comparing the information in this file to the FAA "Regional Active Airmen Totals" gives the count of airmen who declined inclusion in the database.

individual information for every pilot licensed in the United States[19]. The data include 24 different fields for each pilot; including certifications and aircraft type certifications. Each pilot is assigned a unique ID, allowing the combination of data from the two files. These two files were used to build the model baseline for both U.S. and foreign pilots.

- Department of Transportation
  - Air Carrier Financial Reports (Form 41 Financial Data) – Form P-5.2
    This database on operating expenses for large certified U.S. air carriers includes mandatory reporting information, such as salaries, benefits, and expenses for the entire pilot population for each carrier with revenues of over $20M. This information, along with Form P-10, was used to calculate weighted average salaries, benefits, and expenses for the different categories of air carriers.
  - Air Carrier Financial Reports (Form 41 Financial Data) – Form P-10
    This database, *Annual Employee Statistics by Labor Category*, includes mandatory reporting information, including the entire pilot population for each carrier with revenues of over $20M. This information, along with Form P-5.2 was used to calculate weighted average salaries, benefits, and expenses for the different categories of air carriers.
- Major airlines
  - Retirement profiles, attrition numbers, new flight time/duty time rule projected changes
- Regional airlines
  - Retirement profiles, attrition numbers, new flight time/duty time rule projected changes
- Military
  - USAF
    - Air Force Personnel Center *Rated Officer Retention Analysis Pilot, Combat System Officer and Air Battle Manager*
    - Historic and predicted attrition and reasons, separations, and retirement numbers
    - Air Force Rated Aircrew Management System (AFRAMS) model results (blue line or BL)
    - USAF Future requirements (red line or RL)
  - USN, USMC, USA

[19] Pilots can request that their individual information be removed from this releasable database. Comparing the information in this file to the FAA "Regional Active Airmen Totals" gives the count of airmen who declined inclusion in the database.

        - Pilot inventory, fleet size, historic separation numbers, future predicted production and separations

- RAND Corporation (Project Air Force)
    - Total force blue line model (Bigelow Model)
        - Tracks every active, guard, reserve pilot careers 1996-2013[20]
        - USAF pilot inventories (blue line or BL)

Data included in the studies listed in the literature review were used to provide a quality check on the model results, especially with respect to the majors and regionals, the two areas of focus in those studies.

Research Methodology

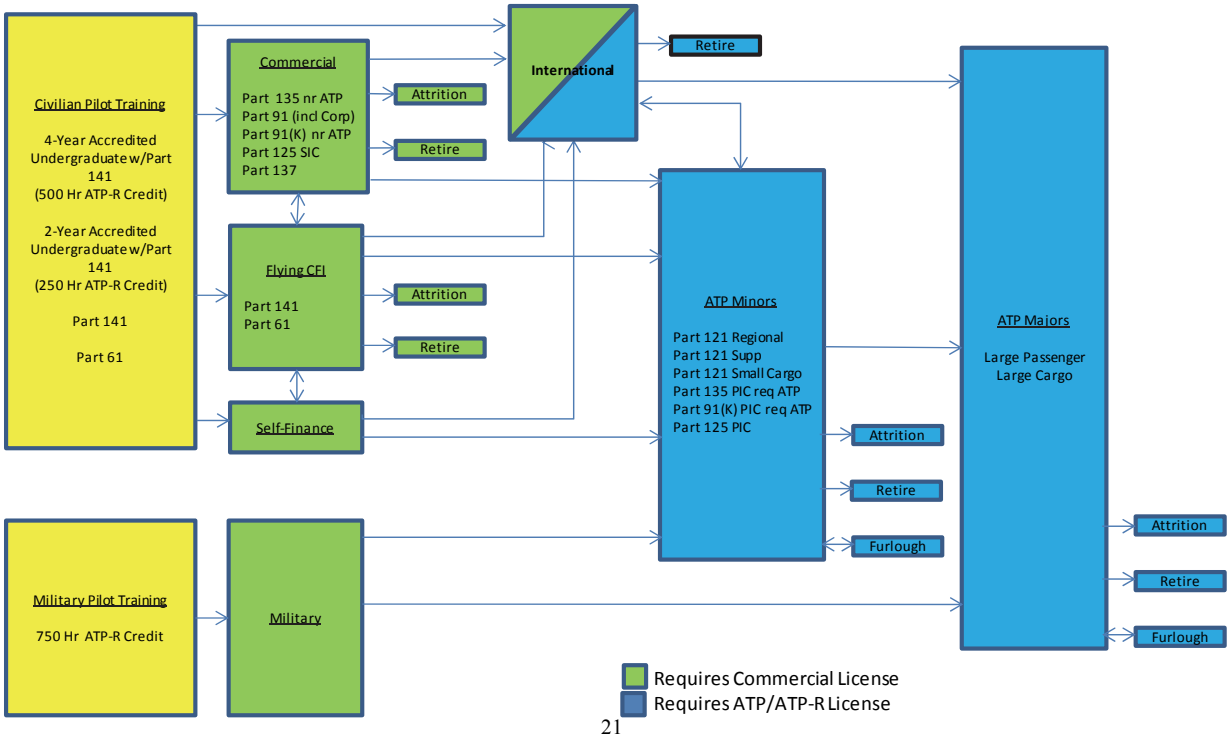
This dissertation includes both quantitative and qualitative analysis. The methodology consisted of three main steps. First, a model was developed to capture the entire supply and demand of professional pilots in the United States. This model captures the flow of professional pilots from civilian and military flight training all the way through employment at major airlines and retirement. Using this model, the second step was to analyze the future supply and demand of pilots in the United States, to include the panoply of effects of recent changes in legislation, as outlined above. The final step was to develop and analyze available policy options that could be used to mitigate any potential shortfalls in the pilot supply chain to meet the predicted future demand.

The Model

The first step in determining the supply and demand for pilots in the United States was to develop a comprehensive model of the environment itself. This model was built with the benefit of: 1) personal experience as a military and professional pilot; 2) consultation with John Allen, the Director of Flight Standards at the U.S. Department of Transportation/FAA; and 3) input and review by multiple personnel directors at both regional and major airlines. This model starts at both civilian and military pilot training, and ends at the major airlines. Figure 1.3 depicts the overall pilot flow used in the U.S. pilot model.

[20] Data pull 24 July 2014

Figure 1.3. Pilot Flow (PF) Model



21

Civilian pipeline

Civilian Pilot Training (Yellow block)

Students begin their career through one of three tracks: a four-year university-affiliated flight-training program, a two-year college-affiliated flight-training program, or an independent Part 61 or Part 141 flight-training program. Students can jump between tracks, though in most cases the quickest and most economical method is to stay within the track until achieving the desired certificate. Student pilots begin by obtaining a private pilot certificate. This certificate allows pilots to act as pilot-in-command for any plane in which they are qualified and to carry passengers, but not for hire.

Building Experience/Flying for Hire (Green block)

The next two certificates typically obtained are a commercial certificate then a certified flight instructor (CFI) certificate. The commercial certificate allows pilots to carry passengers and cargo for hire, and a CFI certificate allows pilots to instruct student pilots. With the commercial certificate, pilots can fly as captains for certain Part 135 (air taxi) operators that do not require an

[21] Military does not require a commercial license, but their pilot training is equivalent to the training required for a commercial certificate with instrument rating. In fact, after pilot training military pilots can go to the FAA and get a commercial license with instrument rating just based on this training.

ATP, as first officers for all Part 135, Part 137 (agricultural operations such as spraying) operators, and Part 91 (catch-all category, including everything from U.S. Customs, to banner towing, to small corporate) operators. With the CFI certificate, pilots can instruct for Part 141 or Part 61 flight instruction companies. These two certificates allow pilots to seek flying employment, and thus the opportunity to build flight hours towards the next certificate, the ATP certificate. While a third route is to self-finance flight instruction and the accruing of flight hours, this route is cost-prohibitive to all but a few. The number of pilots who choose this route will not affect the model results and thus is not accounted for in this model.

An additional route is for pilots to fly for an international airline. These international pilot jobs range from corporate flying, to small regionals, to major airlines such as Emirates. These airlines typically require a pilot to live outside the United States and to sign a multi-year contract (or training bond). Pay and benefits are usually substantially better than beginning salaries for equivalent flying jobs in the United States. Although the numbers of U.S. pilots who choose to take this career path is currently low, the major competition for hiring is with regional airlines as discussed in the following section. Some pilots leave to fly for the international airlines and never return to the U.S. system, though these numbers are very low compared with the total population.

Airlines (Blue blocks)

The ATP certificate allows pilots to fly for Part 121 operators (airlines) as a captain or as a first officer,[22] as a captain for Part 135 operators in aircraft requiring an ATP certificate, or for Part 91K (Fractionals) operators requiring an ATP. Additionally, some operators regularly require ATP certificates for employment, such as Part 125 (large corporate turbine) operators.[23] Once obtaining the ATP/R-ATP certificate, pilots who desire to fly for the majors typically apply for a minor Part 121 carrier. These include regional airlines, small Part 121 cargo carriers, or small Part 121 charter carriers, to build time and experience to qualify as a competitive candidate for a major airline.

As discussed above, another option for U.S. pilots to build experience is flying for international airlines. New ATP certificated pilots with close to the minimum hour requirements are not currently competitive for major airline employment. Instead of flying with a regional airline (low starting pay and a 50- to 70-passenger aircraft), a new ATP pilot can choose to fly for an international airline. These airlines fly the same equipment as the U.S. major airlines and offer much higher starting wages than U.S. regionals. The drawback for some is the requirement

[22] Part 121 FOs can fly for the airlines with a restricted ATP certificate, R-ATP

[23] Although Part 125 operations require a commercial license, the common practice for Part 125 operators is for at least the captains to have an ATP license. Part 125 is unique in that the FAA requires the PIC of a Part 125 operator to have at least 1000 total flight hours and 500 hours of cross-country time, which is more than most R-ATP requirements. Thus, Part 125 captains are accounted for in the R-ATP required accounting block, whereas first officers are accounted for in the commercial-required block of the model.

to live overseas, but it is another option for young pilots and allows them to gain experience flying large aircraft, which makes them very competitive for future U.S. major airline employment. There are also some opportunities for new commercial certificated pilots to fly with charter and corporate operations overseas to build flight time and experience, though the salaries and benefits offered are much less than for ATP pilots.

The final step for most pilots flying professionally is the move to the major U.S. airlines. The majors are thought of as destination airlines, with which pilots will stay with for a career if possible primarily because of the lucrative pay scales and retirement plans. Some pilots choose to spend their entire Part 121 career at a company listed in the minors. This is often because of reasons other than pay, such as seniority and quality of life. Appendix B breaks down the list of Part 121 carriers accounted for in the majors passenger, majors cargo, minors passenger, and minors cargo categorization. Although most majors pay scales top out at over $230/flight hour for captains, this study used $150/flight hour as the cutoff between majors and minors.[24] Additionally, some companies, such as Part 125 operators, pay similar salaries to the majors, but they were included in the minors because of lack of industry-wide pay data. The other minors are Part 135 operators whose PICs require an ATP, Part 91(K) operators whose PICs require an ATP, and Part 125s[25].

Losses

At every step of the model, a certain number of pilots drop out of the system. These are depicted by the "Retire", "Attrition", and "Furlough" boxes. Retirement is self-explanatory. Attrition encompasses dropouts because of a loss of medical qualification, a release from employment as a result of disciplinary actions, or a self-initiated change in career. Furloughs are most common for Part 121 operators and are included as potential flows at that level. Furloughs occur when airlines contract. They lay off pilots without pay until they start hiring again, at which point they offer those positions back to the furloughed pilots.

Military Pipeline

The military pipeline for this model is simplified. The model only tracks pilots entering the civilian system from the military system. Military pilot training is governed by the individual service. Military pilot training is highly structured, trains using complex aircraft, and typically lasts approximately one year. Military pilots gain the equivalent of a commercial certificate with an instrument rating upon graduation from pilot training. The FAA issues this equivalent rating

---

[24] This study used a maximum pay scale above $150/hr., retirement plan, flying aircraft Boeing 737/Airbus 320 or larger. Additionally, the operator's average pilot salaries are over $100,000 as determined by Department of Transportation Schedules P-5.2 and P-10.

[25] Although Part 125 operations require a commercial license, the common practice for Part 125 operators is for at least the captains to have an ATP license. Thus, Part 125 captains are accounted for in the R-ATP required accounting block, whereas first officers are accounted for in the commercial-required block of the model.

to any military pilot who requests this conversion. After successfully completing pilot training, pilots in the active duty air force (RegAF) incur a 10-year Active Duty Service Commitment (ADSC), so their first opportunity to leave active duty occurs approximately at the 11-year point in their career.

RegAF pilots can separate from the RegAF and join the airlines any time after the end of their ADSC. Most pilots who desire a career in the airlines separate at that point, although some wait until the 20-year point to gain military retirement benefits and then apply for the airlines. The model assumes that RegAF pilots leaving the military system will only apply for the major airlines.[26] Only the major airlines offer salaries that will equal their last year military salaries within five years of employment. Some military pilots who join the civilian ranks will also affiliate with Air National Guard or Air Force Reserve units on a part-time basis, though this affiliation does not affect the overall numbers in the model.

Other Model Assumptions

The number of new certified flight instructors produced is used in this study as a proxy for number of pilots entering the professional aviation career track and represents the population that potentially desires a career in the major airlines. As noted in the 2013 Pilot Source Study, 87 percent of Part 121 regional pilots hired between 2005 and 2011 had a CFI certificate at some point in their career (Smith 2013). The downside of using CFIs as a proxy is that not all CFIs desire a career at the majors. The other potential proxy is commercial certificates issued. The problem with that proxy is the large number of foreign student pilots who obtain a commercial certificate in the United States and then return to their home country to fly. It is estimated that in 2012, roughly 45 percent of new commercial pilots were not U.S. citizens (Higgins, Lovelace et al. 2013). There are also a number of commercial certificate holders who do not desire a career with the airlines, but get the certificate for reasons such as lowering their insurance rates and continuing training for their personal or business flying.

This model assumes Part 142 operators hire either airline retirees, former airline pilots who no longer fly due to medical reasons, or is an additional job for active ATPs, and thus does not significantly affect ATP flows. Part 142 training centers focus on ground and simulator training, typically for advanced licensing training.

[26] In a 2013 Pilot Source Study, only 4 percent of regional airline pilots hired between 2005 and 2011 had previous military experience (Smith 2013). There are also a number of young part-time ANG and AFR pilots who fly for the regionals to build flight time and gain Part 121 experience to become competitive applicants for the majors. These pilots are accounted for in the minors node.

2013 Baseline

Civilian

The model starts at time step 0, the end of CY14. To calculate the stock, or number of pilots at each node in the model, this study uses two baseline files, which list mandatory reporting information from air operators in the United States. These files include the *FAA Air Operator Aircraft Table* and the *FAA Air Operator Information Table*. These databases, when combined, include all the reported pilots and aircraft for every Part 91, Part 91K, Part 121, Part 125, Part 129, Part 133, Part 135, Part 137, and Part 121/135 operator in the U.S. They also break down PIC, SIC, check airmen[27], and trainees[28]. After removing all inactive certificates, entries for Part 133 (Rotorcraft External-Load Operations) operators and aircraft, Part 129 (Foreign air carriers and foreign operators of U.S.-registered aircraft engaged in common carriage) operators and aircraft, and helicopter pilots/aircraft/operations, the resulting data show a complete picture of fixed-wing operators and pilots for each active operator within the United States.

Further breakout is required for Part 91, Part 91(K), Part 125, Part 135, and corporate operators to approximate the numbers of ATP and commercial certificate required pilots for the baseline. As discussed above, new FAA regulations require the PIC in certain operations under Part 135 and Part 91(k) to hold an ATP. Additionally, it is common practice to require Part 125 PICs flying large multi-engine turbine aircraft to have an ATP for employment. These breakouts are required to create an accurate baseline of the numbers of ATPs required in the U.S. system. Using the files listed above, it is possible to use the types of aircraft listed to determine the numbers of Part 135 and 91(K) operations using aircraft that require an ATP PIC. A table was built breaking out operations and their associated pilots that flew: 1) commuter operations using multi-engine airplanes with nine or fewer passenger seats, 2) on-demand operations using multiengine airplanes with 10 or more passenger seats, and 3) turbojets. These operations required a PIC with an ATP. The same method was used for determining which Part 91K operations flew multi-engine turbine-powered fixed-wing airplanes, also requiring an ATP PIC. These same rules were applied to Part 125 operations to determine their initial population of ATP PICs.

The international node is only concerned with the numbers of U.S. pilots currently flying overseas for foreign airlines. The numbers of active pilots who were certificated in the United States with overseas addresses is listed by the FAA.[29] This lists 17,214 commercial pilots and 8,569 ATP certificated pilots. These numbers include not only U.S. citizens but also recently certificated foreign pilots who received their certificate in the United States, moved back to their home country, and are not candidates to fly in the US system. To identify the U.S. citizens,

[27] A pilot authorized to give FAA check rides (flight examinations)

[28] Pilots in training at the company

[29] Can be found at http://registry.faa.gov/activeairmen/M70_Active_Pilots_Detail_Foreign.pdf

another approach was used. Both the list of FAA-issued pilot certificate certifications (pilot_cert) and pilot medical certifications (pilot_basic) were downloaded from the Airmen Certification Database.[30] Using the Pilot IDs[31] listed in both files, they were matched to make a master file of pilots, their certificates, their medical certification types and valid dates, and their countries of residence. One concern was missing data, since pilots can elect not to have their information in this releasable file. However, the numbers of foreign-based pilots matched closely with the actual numbers of FAA published foreign based pilots, which indicated that this database was sufficiently accurate. The created database had 17,085 of the 17,214 total (99.3 percent) foreign-based pilots with a U.S. commercial certificate, and 8,107 of the 8,569 total (94.6 percent) foreign-based pilots with a U.S. ATP certificate. This is a sufficiently complete database, indicating not many foreign-based pilots opt out of the releasable list. To filter out foreign citizens from this file, the study used a longitudinal comparison between August 2013 and May 2014, and kept only the pilots who showed up in both files. Medical examinations required for ATP and commercial operations must be renewed every 6 or 12 months depending on the type of flight operation (FAA 2013). Assuming the medical exams are passed as a prerequisite for gaining an ATP certificate, foreign pilots who convert their FAA certificate to their home country's certificate will drop out between the two time periods. Those who remain are foreign-based pilots who are U.S. citizens. There were 3075 pilots with a fixed-wing commercial certificate and a valid Class 1 or 2 medical that remained in both databases. There were 3502 pilots with a fixed-wing ATP certificate and a valid Class 1 medical in both databases.

To finish the baseline, this study used *FAA Aircraft Type Ratings, Special Curricula, and other Approved Training Course Outlines* and the *FAA Certificated Pilot Schools - 141 specific information* files.[32] These databases, when combined, include all the reported pilots, aircraft, numbers of trained pilots, and training capacity for every Part 141 operator in the United States. After removing all inactive certificates, the resulting data shows a complete picture of active Part 141 operators within the United States. To filter out the helicopter-focused schools, only schools flying fixed-wing aircraft and offering either commercial (Single-engine Land, Single-engine Sea, Multi-engine Land, Multi-engine Sea) or CFI (Single-engine or Multi-engine) certificate training as a minimum were included. To complete the training picture, the FAA General Aviation and Air Taxi Survey (GAATS) was used to determine the Part 61 population. The GAATS includes data for Part 61 and Part 141 combined. The difference between the Part 141-specific data and the entire training population data is the Part 61 population. The Instructor/Aircraft ratio for all Part 141 schools combined was applied to Part 61 aircraft to estimate the number of active Part 61 instructor pilots.

---

[30] Downloaded from http://www.faa.gov/licenses_certificates/airmen_certification/releasable_airmen_download/

[31] Random letter/number designation assigned by the FAA to each pilot

[32] Both were downloaded from http://av-info.faa.gov/dd_sublevel.asp?Folder=%5CPilotSchools.

These four data sources, when combined, provide a starting reference point for the stocks, or numbers of active aircraft and pilots within the United States for each civilian node in the model, from civilian pilot training through the major air carriers.[33] The following table lists the starting stocks for each civilian node in the model. The listing for the different categories of Part 121, Part 91, Part 135/91(K), 125, and 137 are listed in Appendix B.

Table 1.3. 2013 Stocks of Civilian Pilots in the United States

CFI	Commercial	ATP and ATP-R		
		Minors		Majors
Total Part 141/61 CFIs	Part 135, Part 137, Part 125, Part 91, Corporate	Part 135/91(K) PIC Req ATP /Part 125 PIC	Part 121 Minors	Part 121 Majors
Total	Total	Total	Total	Total
10181	30137	16047	23245	59860

International based U.S. Pilots	
Commercial	ATP
3075	3502

SOURCE: PF Model

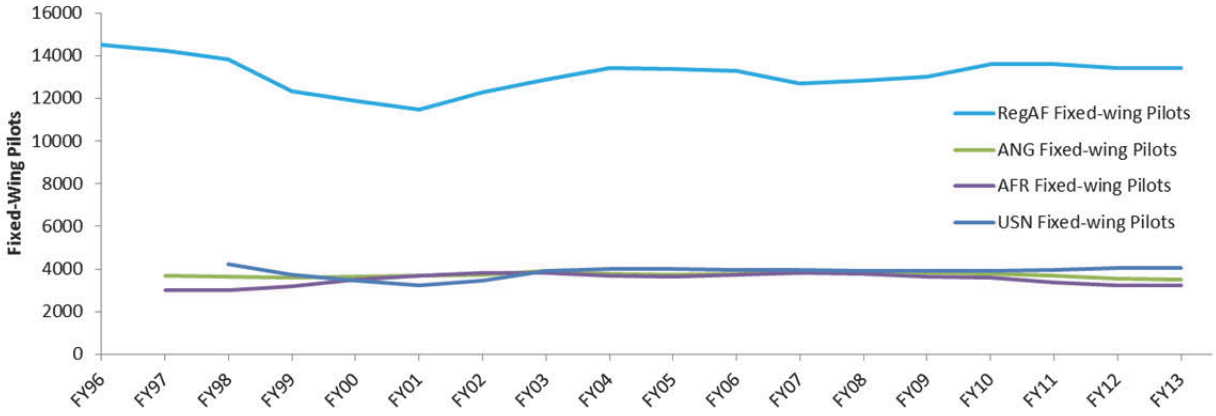
Military

The baseline for the numbers of military pilots was built from numerous sources. The current and historical numbers of USAF pilots were derived using the personnel files sent to RAND Corporation monthly by the Air Force Personnel Center (AFPC). These files are parsed and analyzed by Dr Jim Bigelow as part of Project Air Force and funded by the USAF. The current and historical numbers for the USN were provided by Office of the Chief of Naval Operations (OPNAV). The USMC and U.S. Army fixed-wing pilot data were generated from information provided by the services to the U.S. Government Accountability Office (GAO) at the end of CY13. Military pilots are, and will continue to be, a steady source of new hires for the majors. The following chart shows the numbers of fixed-wing pilots (exclusive of RPA/drone pilots) in the USAF and USN over the past 18 years[34]. The numbers of fixed-wing pilots in both the USAF and USN were higher at the end of 2013 than they were in 2000.

[33] The data pull occurred in May 2014. Due to annual reporting timelines, the reported data covers reporting during the timeline June 2013-May 2014. Thus, data could be up to +/- 6 months from the model starting point of December 2014.

[34] USA and USMC numbers are not included here because their contribution to the pipeline is minimal and the data on these two services was not as precise as the data from the USAF and USN.

Figure 1.4. Total Fixed-wing Pilot Inventories, USAF and USN



SOURCE: RAND TFAM model for RegAF, ANG, AFR, OPNAV for USN

Pilot Demand

At each level of the model, four things drive pilot demand:

1. Fleet growth (or contraction)
2. Retirements
3. Loss as a result of career progression (e.g., regional pilots leaving to the majors)
4. Attrition (e.g., loss of medical certification, termination, change of career)

Calculations for each driver are discussed below for each level of the model. The new FT/DT rules that went into effect January 2014 created a near-term demand that is also captured in the model. It is also discussed below. The specific equations used in the model are included in Appendix A

Loss Due to Fleet Growth (or Contraction)

Majors

The FAA breaks out its forecast for U.S. mainline air carriers and cargo by narrowbody (2, 3, and 4-engine) and widebody (2, 3, and 4-engine) aircraft. Its forecast does not break out growth per airline; rather it spreads across all the mainline or major air carriers. This growth (or contraction) in aircraft can be translated into growth (or contraction) in pilot numbers by determining the pilots/aircraft ratio for the operators. To calculate correctly the change in pilots because of fleet change forecast, a distinction must be drawn for carriers using widebody and narrowbody aircraft. Using the FAA operator files, the numbers of widebody aircraft and operators can be calculated. Delta, United, American, and Hawaiian fly widebody aircraft and average 14.04 pilots/aircraft across their entire widebody and narrowbody fleet. The operators who fly only narrowbody aircraft average 12.49 pilots/aircraft. The difference is attributable to not only different route structures, but also in some cases to the fact that widebody aircraft are

also used for international routes requiring more than one crew because of the length of the flight. Using the numbers of widebody aircraft at each of the four airlines, numbers of pilots can be matched to numbers and types of aircraft starting at the baseline. It is assumed that the 12.49 pilots/aircraft can be applied as an average across narrowbody fleet manning at those airlines that also fly widebody aircraft. This results in a widebody average manning of 21.2 pilots/aircraft. The pilots/aircraft calculations can then be applied separately for the future forecasts of mainline narrowbody and widebody fleet growths. This method was applied to network, domestic, and cargo operators in the major node.

Regionals

The FAA breaks out its forecast for regional carriers into five categories: fewer than nine seats, 10-19, 20-30, 31-40, and over 40 seats. While its forecast does not break out growth per airline, it is growth spread across all the regional air carriers. This growth (or contraction) in aircraft can be translated into growth (or contraction) in numbers of pilots by determining the pilots/aircraft ratio for the operators. To calculate the change in pilots because of fleet change forecast, a distinction must be made between carriers using larger regional aircraft (ERJ, CRJ, Q400), and smaller turboprop aircraft such as EMB 120, B1900D, and Saab 340. Using the FAA operator files, the numbers of larger aircraft and operators can be calculated. For this analysis, this forecast breakout was consolidated into 40 seats or less and over 40 seats. The corresponding pilots/aircraft was then applied to the two consolidated categories.

Part 91, Part 91K, Part 125, Part 135, Part 137

For General Aviation and Air Taxi aircraft, the FAA forecast breaks out single-engine and multi-engine pistons, turboprops, and turbojets. The growth (or contraction) in these categories was applied to the breakout of aircraft in the different categories determined in the baseline for these Parts. The pilots/aircraft ratio determined in the baseline calculations were then applied for the different operator categories for both commercial and ATP-certificated pilots.

Part 141/61

Though the same process described above was used for pilot training organizations, it is recognized that major shifts in demand will eventually create unforecast major shifts in in Part 141/61 operations.

Military

The military services track their current population of pilot inventory compared to their requirements. Requirements are derived from the National Military Strategy (NMS) and refined by Combatant Commander requirements. The services charter is to organize, train, and equip. Thus, they take these wartime and steady state needs and translate them into aircraft and pilot requirements. In the USAF, the inventory of pilots is often referred to as the “blue line” (BL), and the requirements the “red line” (RL). Accessions into the military and force shaping of the

current force are based on the difference between the BL and the RL for the current and the forecast force structure. Approximately two-thirds of the fixed-wing pilots in the military reside in the USAF and are thus the main source of military pilots transitioning to the majors. This study had access to primary USAF and USN data, and secondary data for the USMC, and USA.

Loss Due to Retirements

Majors

The process to determine mandatory retirements for the majors required getting age profiles from each of the majors, then combining those lists for the entire node. For passenger operations, data were obtained from Delta, American, United, Southwest, Alaska, JetBlue, U.S. Air, and Virgin. This represents 95.7 percent of the total majors' passenger operator data. This study estimates that the retirement behavior of the missing 4.3 percent of pilots was not significantly different from the known data, and thus the known data were adjusted to account for this missing data. For cargo operations, data were obtained from airline sources for FedEx, UPS, and Atlas. This represents 89.4 percent of the total majors' cargo operator data. This study estimates the behavior of the missing 10.6 percent of pilots did not differ significantly from the known data, and thus the known data were adjusted to account for this missing data.

This data would be final if all pilots actually flew until their mandatory retirement age of 65. In 2012, however, Delta Airlines conducted a study of airline pilot retirements. It found that approximately 10 percent of any given year group began retiring (non early-out) each year between age 60 and 65.(Delta 2012) The baseline retirement data were adjusted in the model to account for this behavior. Figure 1.5 shows the baseline data and the adjusted retirement data for the combined passenger and cargo majors. Owing to the predicted growth in hiring, this study does not model any future early-out programs for the majors.

Regionals

The 2012 Delta Pilot Age study surveyed eight regionals: Air Wisconsin, American Eagle, Compass, Horizon, Jazz, Mesa, Piedmont, and PSA. In addition, this study added data from Pinnacle (now Endeavor) to their data. The resulting data encompassed 9821 pilots, or 44 percent of the total regionals pilot population. Their findings were not surprising in that they showed the following:

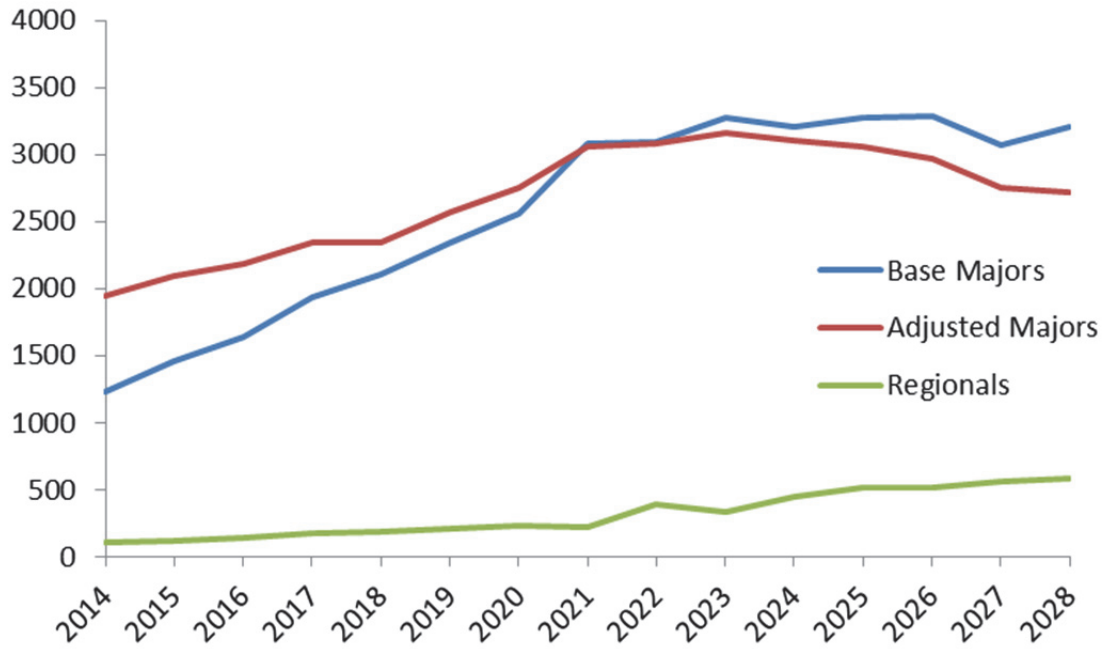
1. Average regional pilot age is much younger (39.7 years) than their counterparts in the majors (49.9 years old)
2. Percentages of the population who retire from the regionals are much less than their counterparts in the majors (Delta 2012),

This retirement profile, based on respective node pilot population, is used for all nodes other than the majors.

Figure 1.5 shows the comparison data between the majors and the regionals. Note: the significant difference in the early years is because those pilots who retired early from the 2014 -

2017 year groups had already dropped from the base case airline manning numbers when these numbers were pulled from the respective airline systems.

Figure 1.5. Predicted Retirements for the Majors and Regionals



SOURCE: PF Model

Part 91, Part 91K, Part 125, Part 135, Part 137, Part 141/61

Without specific retirement data on these operators, this study used a mixture of the percentages of total population to approximate retirements. For all commercial pilots at these operations, the "non-destination" retirement profile that was generated for the regionals was applied; meaning the numbers of retirements was minimal compared to the majors. For Part 135/91(K)/125 ATP pilots, the "non-destination" retirement profile was also applied. This grouping of operators varies widely from pilots flying smaller turbines to Boeing 747s. This study assumed the non-destination profile more closely modeled this groupings behavior. This decision will result in a slight underestimation in the numbers of retirements in this grouping.

Loss due to career progression

Majors

This is not calculated at the majors level since this is the destination node. While there may be some movement between recently hired pilots at the smaller majors, such as Spirit, to a network carrier, such as United, it is assumed all of the majors are valid destination companies and thus shifts within the node are not tracked.

All others

It is assumed that pilots flow from the left to the right in Figure 1.3. At each time step (time step 0 = 2013, time step 1 = 2014, etc.), the model combines the internodal losses with the intranodal losses and assumes these losses will be filled by pilots progressing in their careers from nodes to the left. Each of the "non-destination" nodes will experience these losses as pilots leave to continue their professional career elsewhere.

Loss Due to Attrition (loss of medical clearance, termination, change of career)

Of the three demand drivers for the majors, attrition is the most difficult parameter to calculate. The 2013 UND study attempted to use the entire commercial and ATP population, adjusted for new pilots and retirements and the fact that major airline pilots account for only 21 percent of that population. Researchers calculated a multi-year mean of 1.52 percent. The problem with this method of calculation is that it assumes that the medical health and career behavior for major airline pilots are similar to the total population of non-professional civilian pilots with a commercial certificate, commercial pilots working for $20,000/year, and ATP-certificated pilots who do not fly for the major airlines.

This study uses a different approach. For the majors, it uses data from the two largest companies, Delta and United, to approximate this value. It is assumed that at the top tier of professional flying, these attrition levels would be the lowest of any node. Both Delta and United confirmed that using 0.5 percent was a better approximation of majors attrition. Analysis of data provided by Delta for CY13 and the first 8 months of 2014 showed 0.47 percent attrition resulting from Conditional Termination, Deceased, Sick Leave of Absence over 10 years, and Terminated. The 2013 United study used this same value for its future attrition.[35] This value was used across the majors.

Attrition at the other nodes was modeled after attrition at the regionals. ExpressJet, the largest regional, published details on their losses in 2012(Greubel 2013) and 2014(Expressjet 2014). This loss data were used to approximate attrition for other nodes not in the "destination" groupings. For losses because of termination or career change, ExpressJet reported 0.76 percent of their total pilot population in 2012 and 0.6 percent for the first seven months of 2014 (extrapolated to 1.03 percent for full year). Though these data only represent 21 percent of the total regionals pilot population and only include 19 months of data, they allow for a gross approximation for "non-destination" type nodes. Attrition of 1 percent was used at all "non-destination nodes". It is a valid assumption that the nodes earlier in a pilot's career will experience higher attrition than is seen at the regionals (proxy for "non-destination" nodes), but this study found no valid attrition data on these nodes. Attrition calculations will underestimate losses at the nodes below the regionals.

---

[35] Though the United study used 0.5 percent for their attrition (based on historical rates), their actual attrition in CY13 was only 0.21 percent.

Flight Time/Duty Time

The new FT/DT rules, which went into effect in January 2014, created a near-term increase in demand that is captured in the model. The approximations used for the majors and the minors are based on published data and interviews with representatives from United, Delta, Alaska, and ExpressJet. The predictions for the majors were 3.1 percent (United 2013) and 7-10 percent (Garton 2011) for the regionals in early 2013, a year before the new rules were implemented. Both the majors and the regionals have revised their numbers post implementation. For the majors, the model uses 1.5 percent of total population to meet the airline demands of implementing the new FT/DT FAA rules, with 50 percent of those pilots hired in 2013 and 50 percent hired in 2014. For the minors, the model uses 4 percent of the total population to meet the airline demands of implementing the new FAA rules, with 50 percent of those pilots hired in 2013 and 50 percent hired in 2014.

Pilot Supply

Supply for the ATP majors in the model is constrained to pilots from the military or ATP-certificated pilots from the minors, including Part 121 regionals, small charter, or small cargo, PICs of Part 135 operations requiring an ATP, PICs of Part 91(K) operations requiring an ATP, or PICs of Part 125 operations. The model assumes all military pilots who separate at the 11-year point or beyond and who desire a career with the majors will be hired. In the FAA publication *Pilot Certification and Qualification Requirements for Air Carrier Operations*, the FAA explained its reasoning behind allowing military pilots the lowest minimum time to qualify for an R-ATP certificate. It not only cited a strict selection process, but also noted a concentrated and rigorous pilot training, and a known high standard of required performance (FAA 2012). This initial training and known continuing training throughout the military pilots' careers offer the airlines a known quantity when hiring a military pilot. These are the reasons military pilots are highly sought after by Delta, United, and Southwest. However, not all separating pilots desire to fly for the airlines. Based on available data from Delta and United and the 2007 RAND study, this model assesses that 75 percent of those military pilots who separate before retirement desire a career with the airlines, and only 25 percent of those pilots who retire from the military desire a career with the airlines.

Supply for the ATP minors include commercial pilots from Part 91 operations, including small corporate operations, Part 137 operations, Part 135 operations not requiring an ATP, SICs from Part 135 operations that require an ATP, SICs of Part 91(K) operations requiring an ATP, SICs of Part 125 operations, or CFIs from Part 61/141 flight schools.

Supply for Part 91 operations, Part 137 operations, Part 135 operations not requiring an ATP, SICs from Part 135 operations which require an ATP, SICs of Part 91(K) operations requiring an ATP, SICs of Part 125 operations, SICs of large corporate operations, or CFIs from Part 61/141 flight schools comes from four-year undergraduate universities with an affiliated Part 141

program, two-year undergraduate colleges with an affiliated Part 141 program, a stand-alone Part 141 flight school, or a Part 61 flight school.

The model assumes each node will be supplied from the previous sets of nodes.

This required delay has no effect on military pilots since their minimum time for entry into the ATP nodes is 10 years after pilot training, the end of their ADSC. Some young part-time Guard or Reserve pilots who qualify for the majors (750 hours for an R-ATP) but do not feel they have enough experience to get hired by the majors, fly for the regionals to build flight hours and experience. These pilots are counted in the minors node and not the military supply pipeline.

---

2. Literature Review

Current literature on this issue varies widely, based on data assumptions and methodology. Since the announcement of Public Law 111-216, the Airline Safety and Federal Aviation Administration Extension Act of 2010, multiple academic and industry studies have analyzed aspects of the pilot supply and demand, or required and available stock, issue.

The current studies predict drastically different outcomes from the legislation. The authors ranged from academic institutions associated with aviation, to a federally funded research and development center (FFRDC), to a private industry analysis firm, to the airline and aircraft manufacturing industry itself. Their conclusions range from the prediction of a significant shortage of pilots (Higgins, Lovelace et al. 2013), to shortfalls requiring major policy changes to mitigate (Malaud 2011), to minor shortages that the market will adjust to nullify (Berry 2013), to no shortages at all (Harrison 2013). Of note, all of the commercial industry-conducted studies conclude a combination of Public Law 111-216 implementation, pilot retirements, and airline industry growth will result in significant pilot shortages over the next 20 years.

Though all use similar data, the models used to analyze the data range from simplistic bi-nodal to robust multi-nodal. Another significant difference in the studies and their outcomes is the assumptions made on the data and the inter-nodal transitions. These differing assumptions result in drastically different conclusions on the issue of future pilot shortages. The goal of this study is to model completely all of the nodes and transitions, minimize the assumptions, and capture the range of future possible scenarios.

The following studies analyzed the current pilot supply, the current pilot demand, or both.

ATP Supply and Demand

In April 2013, the MITRE Corporation briefed its study *Pilot Supply Outlook* at the World Aviation Training Conference. This study asks if a "perfect storm" of current policy, demographics, and incentives will cause a pilot shortage. The policy section refers to the new first officer qualification rules and the new flight time/duty time rules. The demographics section primarily looked at the effects of airline pilot retirements. The incentive section investigated the effect of foreign airline draw and the high cost of meeting the new minimum requirements. This study took a macro view of the pilot supply/demand issue, focusing on total inputs and outputs to the airline industry. However, the study did not generate or investigate a detailed model; rather, it looked at total numbers of student, commercial, and airline transport certificates issued in the United States.

The analysis employed the following logic. The number of commercial pilots under the age of 35 has remained steady and is significantly larger than the 4000-4500 anticipated ATP

attrition rates. There is a strong correlation between ATP hiring rates and new ATP certifications. There also is a strong correlation between new commercial pilot certifications among young pilots and new ATP certifications. Thus, as more ATPs are hired, more commercial pilots gain their ATP certifications and more private pilots gain their commercial certifications. The authors conclude, "In the medium (3 years) term and beyond, there will not be a shortage of pilots available to become ATPs. Further, the more hiring at the ATP level, the more pilots will enter the commercial pilot pool" (Berry 2013).

MITRE also discusses the fact there are approximately 8000 pilots flying for foreign airlines who gained their ATP certification in the United States, and over 17000 pilots flying for foreign carriers who gained their commercial certification in the United States. They specifically assume these pilots are flying for foreign carriers because they could not find acceptable flying jobs for U.S. air carriers and would return to the United States if acceptable positions opened up. Their hypothesis is that a significant portion of any near-term shortage could be fixed with this pool of pilots. This is a good example of what may be a faulty assumption. According to the FAA's certification branch, over 45 percent of FAA commercial certifications granted in 2012 were to foreign nationals who had travelled to the United States for their commercial certification training. These foreign national pilots are not realistic candidates for U.S. airline employment. They are not flying for foreign airlines because they could not get hired in the United States. Rather they trained in the United States so they could fly for a foreign airline.

Another finding from this MITRE study is that university flight schools are a major beneficiary of the new first officer qualification rules. They concluded that the exemption allowing graduates to gain their ATP certification in a third less time, the ability for students to finance their flying through federally subsidized loans, and their follow-on CFI programs to build flight time would result in these programs being the preferred route for new pilots.

An Investigation of the United States Airline Pilot Labor Supply was recently completed in April 2013 by a consortium of six universities[36] with aviation programs. This is the most complete study to date with respect to the wide range of issues covered. Their conclusion was, "It is clear from the data that the United States faces a shortage of airline pilots." (Higgins, Lovelace et al. 2013) This study used a model-based approach focusing on the majors, and the CFIs who feed the majors demand in the future. To calculate demand, the study used Airline Monitor data for future majors fleet projections, Airlines for America (A4A) data for majors retirements, and calculates attrition for other reasons (discussed later). On the supply side, this study looked at six different variables in an attempt to predict future CFI production: starting pay at regional airlines, high school student interest in aviation careers, prestige of being an airline

[36] University of North Dakota, University of Nebraska Omaha, Embry Riddle Aeronautical University, Southern Illinois University, LeTourneau University, Middle Tennessee State University

pilot, job satisfaction of being an airline pilot, cost of flight training, and hiring at major airlines.[37] Of the six, only two were found to be significant.

The study presented the resulting regression equation (adjusted $R^2 = .774$):

$Y = .31X - 84.60Z - .14XZ + 4593.78$ (Higgins, Lovelace et al. 2013)

Where:

y = Future Certified Flight Instructors over the next 3 years;

x = Number of pilots hired at major airlines;

z = Percent change in cost of obtaining Private Pilot certification (adjusted for inflation).

This study uses that equation for the supply input of new CFIs to the system.

Additional data are presented in the study from a Career Aspirations Survey of 1,600 collegiate aviators from the represented universities. Their study data paint an unhealthy picture of the U.S. airline industry with respect to pilot supply:

- 35,000: A status quo projection of the shortage of pilots over the next 10 years
- 78 percent: Number of future ATP candidates from aviation universities who make a consumer decision between risk (cost associated with flight training) and reward (annual number of pilots hired at major airlines)
- 54 percent: Certified Flight Instructors who plan on employment in the airlines as a long-term career plan
- 45 percent: Number of commercial written examinations completed by foreign pilots in 2012
- 33 percent: Future pilots surveyed from aviation universities who are reconsidering a career as an airline pilot due to the new FAA minimum ATP requirements
- 9 percent: Future pilots surveyed from aviation universities who no longer consider a career as an airline pilot due to the new FAA minimum ATP requirements

This study concludes, "For the years 2013 to 2031, there is a forecasted 35,059 pilot shortage" (Higgins, Lovelace et al. 2013). The GAO, however, specifically noted it disagreed with this conclusion based on the UND forecast methodology.[38]

---

[37] High school student interest in aviation careers, prestige of being an airline pilot, and job satisfaction of being an airline pilot we gathered from survey data.

[38] To predict future excess cost growth (the increase in the cost of pilot training over and above the general economy-wide level of inflation), the study extrapolated the growth of inflation in the cost of flight training over the past several years to the next 20 years. While using historic trends to predict future changes is part of forecasting, in some cases, it can lead to results that may be unlikely.57 In this case, this method resulted in forecasted year-over-year changes in the cost of flight school of almost 8 percent above its historic mean by the year 2030, which is well above historic averages over the past 20 years. However, other changes in the market for pilot training, such as the openings of other pilot schools, for example, could reduce this inflation. Using a different assumption regarding increases in training costs would result in different outcomes with respect to the size of the forecasted shortage. In fact, guidance from the Office of Management and Budget suggests that assumptions regarding price increases (such as the continuation of current trends) should be varied to test the sensitivity of the final results to that assumption. This is especially true if the nature of the economic series does not necessarily imply a trend, such as inflation, which measures the change in price and not price itself. For example, over the past 50 years, U.S. inflation has been as high as 14 percent and as low as -0.3 percent, but does not appear to have followed any 20-year trends. For example, we found that reducing the assumed rate of increase of inflation in the cost of flight training to only 1-2

In 2013, Audries Aircraft Analysis published its report, *Pilot Demand Projections/Analysis for the Next 10 Years*. To date, this study is the most complete using the stock and flow methodology, and this study builds on that basic structure. The focus of the Audries study is on regionals and majors. Its basic methodology was to use fleet projections and known age 65 retirements to build a future demand profile. The methodology assumes all airline pilots continue to fly until retirement at age 65, and there is no attrition as a result of medical issues, firings, or career changes. To provide completeness, the study compares its own calculations with the Boeing forecast, the Airbus forecast, the FAA forecast, and the Embraer forecast. This study presents a thorough analysis of the industry. It not only provides insider insights (the author is a first officer at a regional airline), but also bounds the range of future forecasts. This study predicts a contraction at the regionals and a steady growth at the majors. The study comes to a conclusion similar to that of the Government Accountability Office (GAO) study, in that there are currently more qualified pilots than there are positions, and the number of pilots flowing into the system will grow along with airline growth. "If an airline experiences difficulty finding pilots it will not be because there are insufficient qualified pilots, but in this authors opinion, the fault will rest solely with the quality of the airline" (Harrison 2013).

In February 2014, the GAO released its study *Current and Future Availability of Airline Pilots*. The report focused on previously published studies, including the UND study, the Audries study, and the MITRE study. Researchers also used BLS Employment Projections 2012–2022, FAA Forecast 2013-2032. Their main findings are summarized below.

> Historical labor market data from 2000 through 2012 provide mixed evidence as to whether an airline pilot shortage exists. The unemployment rate for the pilot occupation—a key indicator for a shortage—has been much lower than for the economy as a whole, which is consistent with a shortage. On the other hand, wage earnings and employment were not consistent with the existence of a shortage, as data for both indicators showed decreases over the period. In looking forward, to meet the expectation of growth in the industry and to replace expected mandatory age-related pilot retirements, projections indicate the industry will need to hire a few thousand pilots on average each year over the next 10 years. Data indicate that a large pool of qualified pilots exists relative to the projected demand, but whether such pilots are willing or available to work at wages being offered is unknown (GAO 2014).

The study does comment on the UND study prediction of a 35,000 future pilot shortage. Much of this shortage is based on an assumed ever-increasing cost of flight training, which is a negative predictor of future CFIs. The GAO economists caution against using current trends to

---

points above its historic mean resulted in about 30,000 more CFI certifications—largely ameliorating the estimated shortage. However, the researchers stated that they felt that extrapolating from current trends would be the most responsible forecast to consider but agreed that if the costs of training do not continue to increase at an escalating rate, relative to inflation, as the study forecasted, then the estimated shortage of pilots could be mitigated" GAO (2014). "Current and Future Availability of Airline Pilots." (GAO-14-232): 61.

.

forecast future cost growth. In an excursion calculation, "We found that reducing the assumed rate of increase of inflation in the cost of flight training to only 1-2 points above its historic mean resulted in about 30,000 more CFI certifications—largely ameliorating the estimated shortage" (GAO 2014).

In 2011, ICAO published their study *Global and Regional 20-year Forecasts for Pilots, Maintenance Personnel, Air Traffic Controllers* (Doc 9956). This study used a similar methodology as discussed before, but investigated global airlines and focused on the entire commercial and ATP pilot population. The ICAO produced its own future fleet forecast and used each country's specific data (FAA data for the United States) for their retirement profiles. FAA tracks total numbers of commercial and ATP pilots and their ages, allowing the ability to create a retirement profile for those pilots. The obvious drawback from this methodology is that it counts pilots who may be certificated but do not fly professionally. This study also investigated the training capacity for each country to produce professional pilots. The study data suggest the United States has the capacity to train 27,655 pilots annually. This number includes a potential training surplus of over 17,000 pilots from the calculated future requirement of 10,449 new professional pilots created annually (Malaud 2011). Their study predicts significant future growth in the industry, but no system shortage if enough pilots can be enticed to pursue professional flying as a career. Their study concludes there is extra capacity to train the required pilots for any future need in the United States. It also notes that other areas, especially countries in Asia Pacific, Europe, and Latin America, do not have the training capacity to meet the future demand of pilots in those areas.

The Boeing *Current Market Outlook* 2014-2033 is currently the most detailed future fleet projection study. It takes a global look at the majors and regionals airline market. This 2014 version of the annual Boeing study paints an even brighter future for airline industry growth than last year's study. This study predicts an average world economy growth of 3.2 percent over the 20-year span, which they equate to a 5 percent annual growth in passenger traffic and a 4.7 percent annual growth in cargo traffic based on historic trends (Boeing 2014). In North America, Boeing predicts an average 2.9 percent growth in passenger traffic, a 3.4 percent increase in cargo traffic, and a 1.6 percent average fleet growth throughout the next 20 years (Boeing 2014). Boeing predicts the greatest need for pilots will be in the Asia-Pacific regions, with a requirement for 216,000 new pilots over the next 20 years. For North America, Boeing predicts a need of 88,000 pilots over the same time span.

Military

There are multiple studies on the interaction between major airline hiring and separations from the military.

In 2003, a professor at the USAF Academy published an extensive study on the USAF separation in the late 1990s. The individual variables for his model included a pilot's age,

assignment location, assignment type (flying or staff), marital status, number of dependents, family medical needs, source of commission, gender, race, type of aircraft, and expected earnings changes if the pilot joined the airlines. Additional variables included the unemployment rate, airline hires, deployment rates, and a dummy variable for Air Force pilot draw down years. His clear conclusion was clear that "the regression results suggest that the biggest factors contributing to Air Force pilot attrition are still economic factors: pay differences between the airlines and the USAF, the strength of the U.S. economy, and the demand for pilots by the major airlines."(Fullerton 2003) Though the study did not identify the relationship, there is a clear correlation between the economy and airline growth. There is also a clear relationship between airline growth and airline pay. Thus, these three variables cannot be considered discrete. Nonetheless, the study added,

> …each percentage increase in airline hiring relative to the size of the USAF pilot force increased the probability of separation by 1.13 percent. Since 1988, the average hiring/pilot force ratio has been about 18.4, but in FY99, the ratio peaked at almost 40, suggesting an increase in the probability of separation of about 25 percent. Although the variable's impact may not be linear across such a large change in magnitude, it is clear that airline hiring had a huge impact on the retention decisions of pilots.(Fullerton 2003)

In 2004, the RAND Corporation published a study, *Modeling the Departure of Military Pilots from the Services*, funded by the Office of the Secretary of Defense (OSD). This estimation included the following independent variables: marital status, source of commission into the military, type of pilot (fighter, bomber, other), a stop-loss indicator for cohorts that may have been influenced by the Gulf War, eligibility for Voluntary Separation Incentive or Special Separation Bonus (VSI/SSB), measures of deployment and deployment specifically to hostile territories, and hiring by major civilian airlines (Elliott, Kapur et al. 2004). The study found that the most significant predictor of separations of military pilots was civilian airline hiring and incentive pay structures. Table 2.1 indicates how significant these variables are to retention.

Table 2.1. Expected USAF Attrition[39]

Projections: Expected Percentage Point Change in Attrition During the ADSO Window Corresponding to Changes in a Single Independent Variable

Change in Independent Variable	Air Force	Navy
(Historical average quit rate)	(42.4%)	(53.3%)
1,000 total additional hires by major airlines[a]	+14.0%	+4.8%
2,500 total additional hires by major airlines	+35.0%	+10.8%
50% increase in ACP ($37K, $16K PDV)	–12.8%	–13.2%
100% increase in ACP ($74K, $32K PDV)	–24.9%	–25.9%

[a]From all sources, military and non-military.

ADSO – Active Duty Service Obligation, ACP – Aviation Continuation Pay (the "bonus")

The study concluded:

> Increases in major airline hiring are very strongly associated with increases in military pilot attrition, especially for airplane pilots in the Air Force. This finding is particularly interesting in the face of projected long-term increases in major airline hiring.
>
> Although attrition was found to be quite responsive to bonus pay, the magnitude of the effect of major airline hiring could make counteracting a significant increase in hiring quite costly for the services.
>
> The strong influence of civilian major airline hiring on military attrition necessitates a military hiring plan that is capable of responding to strong exogenous influences. It also underlines the importance of incorporating reliable forecasts of major civilian airline hiring into this planning (Elliott, Kapur et al. 2004).

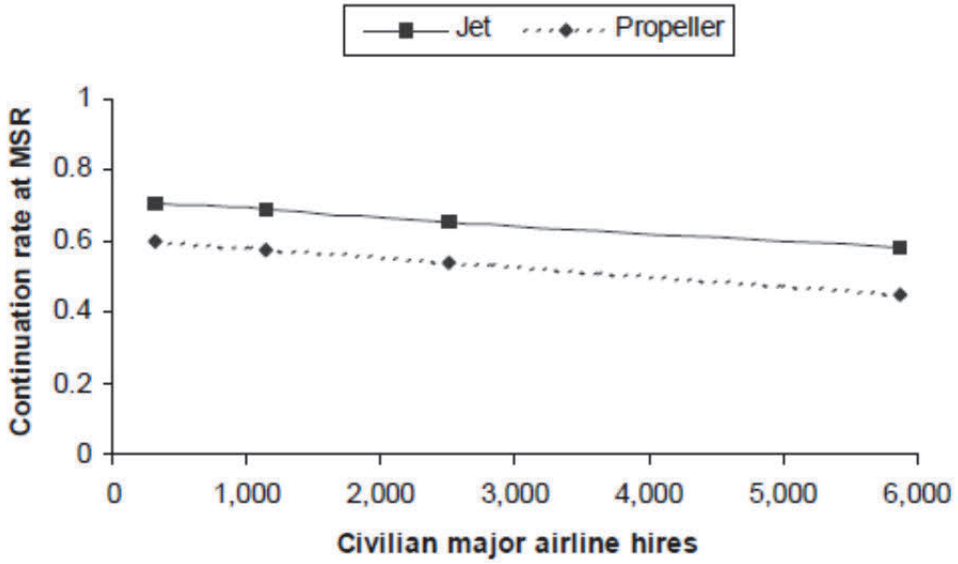
In 2006, the Center for Naval Analysis published, *The Effect of Compensation on Aviator Retention*. This study focused on the empirical relationship between Aviation Career Incentive Pay (ACIP), Aviation Career Continuation Pay (ACCP), and retention of naval aviation officers. The study examined the behavior of helicopter, jet, and propeller pilots from FY85 through FY04 using data provided by Director, Military Personnel Plans and Policy Division, U.S. Navy. The model examined the effect on pilot continuation rates[40] by financial incentives and major

[39] Elliott, M. N., et al. (2004). Modeling the Departure of Military Pilots from the Services. Santa Monica, CA, The RAND Corporation**:** 86.

[40] Continuation rate in this study is defined as the proportion of aviators who remain at the end of each fiscal year.

airline hires during the same timeframe. The study controlled for differences in pilot personnel characteristics (e.g. marriage status, race), Accession source (e.g. academy, ROTC), and characteristics of military service. The study found a clear correlation between continuation rates and major airline hiring.

Figure 2.1. Naval Pilot Continuation Rates versus Major Airline Hiring[41]



The study predicted a 2.3 to 2.7 percent reduction in retention rates for jet and propeller pilots for every 1000-person increase in hires by the major airlines, which is less than the 4.8 percent the previous RAND study predicted for Air Force pilots. To counteract this retention reduction, the study concluded a $5800/year increase in ACCP for jet pilots, and a $3,000/year increase in ACCP for propeller pilots could counteract a 1000-person increase in airline hires. Similar to other studies, the researchers noted, "We do not find a statistically significant relationship between the civilian unemployment rate and pilot retention. In other words, the level of civilian major airline hires appears to be a sufficient proxy for the labor market conditions faced by jet and propeller pilots" (Hansen and Moskowitz 2006).

In 2012, the Air Force Institute of Technology published a report *Predicting Pilot Retention*. The variables investigated included: aviator continuation pay, national unemployment rates, annual airline hires, average airline salary, force shaping programs, marriage rate, time away from home, and promotion factors. The study found a high correlation between separations and airline hiring producing a forward and backwards stepwise regressions equation.

---

[41] Hansen, M. and M. Moskowitz (2006). The Effect of Compensation on Aviator Retention. Alexandria, VA, Center for Naval Analysis**:** 84.

- Forward
  - Predicted CCR[42] = - .011 * PilotHires + 76.893 (adjusted R^2 of .85)
- Backwards
  - Predicted CCR = -19.871 * ForceShape[43] + .522 * ACPrate[44] - .007 * PilotHires + 39.317 (adjusted R^2 of .952)

Both regression equations indicate that airlines hires is the most significant prediction of separations in the USAF. Another interesting conclusion from the study is that national unemployment levels were not found to be statistically significant based on the regression models. It noted "The fact that airline hiring was statistically significant where national unemployment was not suggests that pilots tend to prefer to continue in their aviation duties when leaving active duty if possible."(Stanley 2012) This would indicate a high percentage of pilots who separate from the USAF choose to continue their flying careers with the airlines.

In 2014, Lt Nolan Sweeney wrote a dissertation, *Predicting Active Duty Air Force Pilot Attrition Given an Anticipated Increase in Major Airline Pilot Hiring*. This dissertation specifically focused only on the attrition of USAF pilots in the first three years after their active duty service commitment was completed. While his model is very similar to the model used in the 2004 RAND study, his results differ significantly in magnitude. Though he notes the same trends as the 2004 study, he concludes a significantly smaller ACP increase of only $5,000/year with 50 percent up front and inflation indexing ACIP will decrease pilot attrition by 16 percent (Sweeney 2014). One reason for the significant difference may be the fact that Lt Sweeney used a database that included regional pay to compare military and airline pay, and assumed anywhere from 15 percent to 95 percent of separating pilots flew for the regional airlines after separating from the USAF. The assumption Lt Sweeney makes that a military pilot making over $100,000/year would separate and fly for the regionals at $22,000/year is another reason for the significant difference in conclusions. Nonetheless, the overall conclusions of his dissertation agreed with the four previous studies discussed above, that major airline hiring was by far the most significant predictor or military pilot losses.

Independent Variables

The next section reviews studies that provide information on the independent variables in the pilot supply/demand model. None of these studies tried to answer the complex question of supply and demand, but each of them attacked some piece of the puzzle, and thus these are the building blocks used here in assembling a robust characterization of the problem. These works

[42] CCR is cumulative continuation rate, the percent of pilots in the 6-14 years of service who stay in the military

[43] Variable used to account for years the service employs force shaping, or involuntarily separates pilots

[44] ACP ("the bonus") take rate

thus inform calculations and conclusions employed in particular elements of the pilot supply/demand model in this study.

In 2010, a consortium of aviation universities published, *Pilot Source Study: An Analysis of Pilot Backgrounds and Subsequent Success in U.S. Regional Airline Training Programs*. This study focused on determining the predictors for the success of pilots in initial training for Part 121 operations. The study database included personnel training files for 2,156 newly hired pilots between 2005 and 2009 from 6 regional airlines. Only 3 percent of the pilots in the database had previous military experience. The study concluded: "Statistically, the best-performing pilots were those who had flight instructor certificates, graduated from collegiate-accredited flight programs, received advanced (post-Private) pilot training in college, graduated with collegiate aviation degrees (any aviation discipline), and had between 500 and 1,000 pre-employment flight hours." (Smith, Bjerke et al. 2010) The analyzed variables that showed no significance to training success were: 1) having a non-aviation college degree, and 2) having prior corporate pilot or airline pilot experience.(Smith, Bjerke et al. 2010) The study also broke up the new-hires by the amount of previous flying experience they had obtained before the training. Their order of performance in the training from top to bottom was: Group 1 (501-1000 hours), Group 2 (178-500 hours), Group 3 (1001-1500 hours) and Group 4 (greater than 1500 hours).(Smith, Bjerke et al. 2010)

The *2012 Pilot Source Study (Phase III): Response to the Pilot Certification and Qualification Requirements for Air Carrier Operations* was an extension of two previous studies by a consortium of aviation universities and funded by the FAA. The study database included personnel training files for 4,024 newly hired pilots between 2005 and 2011 from 7 regional airlines. Only 4 percent of the pilots in the database had previous military experience. This study used the same methodology as the 2010 study with different data. The following is the comparison of the results from this study and the previous one completed in 2010.

Table 2.2. Comparison between the 2010 and 2012 Pilot Source Studies[45]

Pilot Source Variable	2010 Pilot Source Study SIGNIFICANT Results	2012 Pilot Source Study SIGNIFICANT Results
College Degree	Not Significant	*Fewer* Extra Training Events
	Not Significant	Not Significant
Aviation Degree	*Fewer* Extra Training Events	*Fewer* Extra Training Events
	More Completions	*More* Completions
AABI Flight Program	*Fewer* Extra Training Events	Not Significant
	More Completions	*More* Completions
Source of Advanced Pilot Training	College: *Fewer* Extra Training Events	College: *Fewer* Extra Training Events
	College: *More* Completions	College: *More* Completions
		Non-College, Part 61: *Fewer* Completions
Pilot Certificates	N/A (not collected)	Not Significant
	N/A (not collected)	Commercial: *More* Completions than ATP
Total Flight Hours	501–1,000 Hours: *Fewer* Extra Training Events	501–1,000 Hours: *More* Extra Training Events
	501–1,000 Hours: *More* Completions	1,001–1,500 Hours: *More* Completions
Flight Instructor	*Fewer* Extra Training Events	Not Significant
	More Completions	*More* Completions
Previous Experience	Not Significant	Airline: *Fewer* Extra Training Events
	Not Significant	Not Significant

In 2007, RAND published a study, *The Relationship of Activation, Pay, and Retention among U.S. Air Force Reserve Pilots*. In this study, the author approximated the number of military pilots who join the airlines after leaving the military. The study merged information from the Social Security Administration and the Defense Manpower Data Center for 4200 Air National Guard and Air Force Reserve pilots between the years 1999-2004. The study compared these data with a *Status of Forces: Reserve Component (SOFRC)* survey for the year 2000. Interestingly, this timeframe captures both the hiring boom of the late 90s and the airline downturn after 9/11. The merged data showed 70 percent of the pilots were employed by the airlines in CY00, 70 percent for CY01, and 67 percent for CY02. As airlines started furloughing pilots during the downturn post-9/11, the percentage in the study dropped off to 58 percent for CY03 and 51 percent in CY04 (Maue 2007). The SOFRC study showed that 75 percent of AF Reserve pilots worked for the airlines in CY00. Based on this study, the Pilot Flow model uses 75 percent for the percentage of separating pilots who affiliate with the majors in increasing airline hire years, and 50 percent for years that airline hires decrease.

In 2007, RAND published a study on an update to its Dynamic Retention Model, used to model monetary incentives for military members. This study, *The Dynamic Retention Model for Air Force Officers*, was funded by the USAF to create a tool for future policy analysis of ACIP[46] and the ACP (Mattock and Arkes 2007). Work is currently continuing at RAND to analyze these incentive programs in light of the current airline hiring increase.

---

[45] Smith, G. M. H., Derek; Bjerke, Elizabeth; Niemczyk, Mary; Nullmeyer, Robert; Paasch, Julie; and NewMyer, David A (2013). "The 2012 Pilot Source Study (Phase III): Response to the Pilot Certification and Qualification Requirements for Air Carrier Operations." Journal of Aviation Technology and Engineering **2**.

[46] Aviation Career Incentive Pay, extra pay military pilots receive. The amount rages from $125/month to $840/month depending on rank and years of service

In 2012, *Delta briefed its North America Mainline Carrier's Pilot Age Study*. This study not only gives important insight into the pilot profiles at the majors and the regionals, but it also provides a quality control check of current retirement data. This study sampled the records of 61,990 pilots from 18 different mainline carriers, including AirTran, Alaska, Allegiant, Air Canada, American, Atlas, Continental, Delta, FedEx, Hawaiian, JetBlue, Southwest, United, UPS, US Air, Virgin America, and West Jet. The average age of these mainline pilots was 49.9, with 30 percent, or 18,492 pilots, between the ages of 55 and 65. Additionally, this study discovered mainline pilots start retiring at age 60, and their cohort loses approximately 10 percent per year to non-early out retirements. They also surveyed the records of 7475 regional pilots from eight different regionals, including Air Wisconsin, American Eagle, Compass, Horizon, Jazz, Mesa, Piedmont, and PSA (Delta 2012). The average age of these mainline pilots was 39.7, with only 8 percent, or 584 pilots, between the ages of 55 and 65 (Delta 2012).

At the winter 2013 Aviation Accreditation Board International (AABI) meeting, United briefed the results of their *UAL Future Pilot Sourcing* study, focused on the future demand at United and their regional partners under United Express. United briefed its future demand at 530 pilots per year for the next 20 years with no growth. United Express required 700 new pilots annually for the same time period (United 2013). United estimated a 3 percent increase for the future FT/DT rules, and a 5-10 percent increase for their regional partners. Note, this briefing was given a year before the FT/DT rules went into effect. In future hiring predictions, United included 0.5 percent as their future attrition in its calculations. This value agrees with the attrition approximation calculation from the Delta data. Another interesting point, based on United data, it estimated 80 percent of former military pilots eventually join the major airlines. It expected to "capture" 15 percent of that pool, or 186 in 2013, making up almost half of its proposed hires in 2013. Confirming data in the previously discussed Delta study, the average age of its regional partners was 36.6 for GoJet, 37.5 for SkyWest, and 36.9 for ExpressJet (United 2013).

In February 2013, American Eagle briefed its *Pilot Source Study* at the AABI Winter meeting. American Eagle is a regional airline, flying 243 Bombardier and Embraer regional jets and employing over 2700 pilots. American Eagle projects it will hire 300-400 pilots in 2013 (Cleveland 2013). As is similar to all regional airlines, their hiring is driven by the following influences:

1. "Flow through" of senior captains to their major "big brother," American Airlines
2. New Flight and Duty Time requirements, which they predict will increase their demand by approximately 7 percent
3. Fleet expansion

It has also noticed a negative trend in supply. In 2011, it averaged 500 active applications on file, offering employment to 53 percent of applicants interviewed. For the first quarter of 2013, it averaged only 100 active applications on file. It offered employment to only 35 percent of applicants interviewed. This decrease was attributed to a number of reasons, including previous

FAA checkride failures and criminal background issues. Their study also accomplished a quick look at performance of their new hires. The data indicate new hires with only 500-800 hours displayed excellent performance during ground and simulator training; however, it did indicate these pilots required additional operating experience in air carrier operations. Additionally, pilots with previous Part 121 or 135 experience displayed good performance throughout their initial training. Those pilots categorized as "second-career pilots"[47] displayed poor performance through initial training. Those pilots with 900-1500 hours were the poorest performers in initial training. Most of these pilots had flight instructor backgrounds, which meant they logged a majority of their flight time teaching but not manipulating the flight controls. In response to the shortage of qualified applicants applying for openings at American Eagle, it is implementing programs it determined would mitigate the upcoming shortage issues:

1. Developing "Bridge" or "Pipeline" programs with aviation universities and commercial aviation schools to hire their instructors when they achieve the minimum ATP requirements
2. Developing an agreement with the American Airlines Flight Department for guaranteed interviews for American Eagle new hires after serving a minimum time as a captain
3. Offering a $5,000 signing bonus for new hires with a two-year commitment
4. Working with aviation universities and commercial aviation schools to develop regional jet transition courses, including use of airline-type policies, technology and equipment to ease their transition from pilot training instructor to regional airline pilot (Cleveland 2013).

In February 2013, ExpressJet briefed its *Pilot Source Study* at the Aviation Accreditation Board International (AABI) winter meeting. Company officials concluded that they are already experiencing the initial wave of a pilot shortage. Although their investigation only looked at their company within their node, they presented many individual data points to support their conclusion. ExpressJet is a regional airline, flying 417 Bombardier and Embraer regional jets and employing over 4500 pilots (Greubel 2013). ExpressJet operates through capacity purchase agreements as American Eagle, Delta Connection, and United Express. The briefing covered CY12 data, including data on losses and new-applicant demographics. During that period, ExpressJet experienced a 4 percent annual loss rate for its pilots. Of the pilots who informed ExpressJet why they were leaving[48], 48 percent left for the majors, 13 percent left for other companies within the minors node (other regionals, cargo, or corporate), 5 percent retired, and 28 percent were attrition (termination or career change). First Officers constituted 57 percent of its losses. New-hire pilots, those with less than two years at ExpressJet, constituted 25 percent of the losses. New captains and older first officers, those with between five and eight years at ExpressJet, made up 45 percent of the losses (Greubel 2013).

[47] "Second-career pilots" are pilots who decided to pursue a career in aviation after completing a first career in another professional field. These pilots are typically in their late thirties or early forties.

[48] Some pilots just quit without giving a reason. Many of these are pilots who leave for other regional competition.

In June of 2012, ExpressJet had over 550 "valid" applications for new pilots on file, with "valid" defined as those with greater than 1400 hours and no issues such as poor driving records, criminal activities, low recent experience, or poor work history. Between October 2012 and February 2013, it averaged less than 100 "valid" applications on file. Anecdotal data indicated a potential decrease in the quality of new applicants.

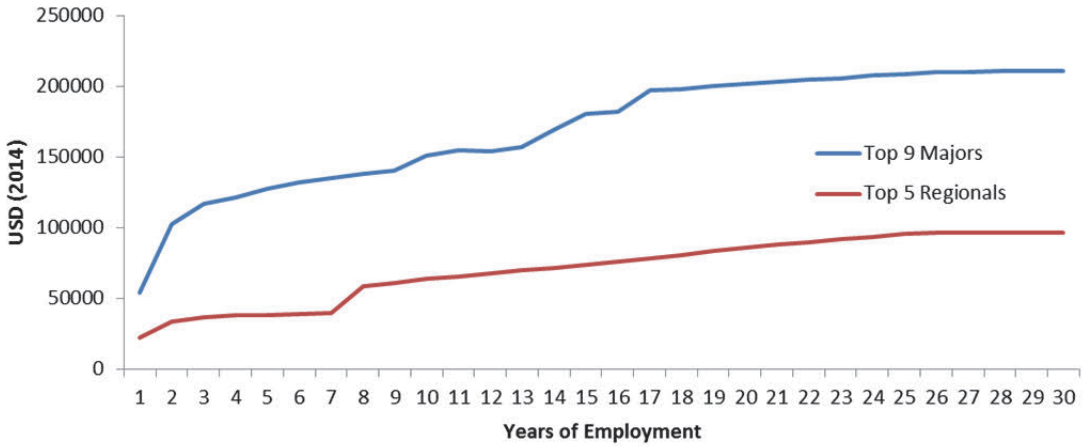
In January 2012, 41 percent of new applicants had a bachelor's degree. This percentage decreased to 28 percent by December 2012. Additionally, the percentage of "additional training" required during the initial training for new hires increased from less than 2 percent "additional training" required in January of 2012 to over 12 percent "additional training" required by December of 2012. Other anecdotal data indicate there may be recent increases in competition for available qualified pilots. In January 2012, it averaged 11 percent "cancellations or no shows" for pre-hire pilot interviews by December 2012. The rate continually increased until I was experiencing 28 percent "cancellations or no-shows" by the last quarter of 2012 (Greubel 2013).

In September 2014, ExpressJet released an update to its previous *Pilot Source Study*. The briefing covered data from January 2014 through the beginning of September 2014, including data on losses and new-applicant demographics. ExpressJet experienced an annual pilot loss rate of 16 percent for the first 8 months of 2014. Of the pilots who informed ExpressJet why they were leaving, 72 percent left for the majors, 14 percent left for other companies within the minors node (other regionals, cargo, or corporate), 4 percent retired, and 10 percent were attrition (termination or career change). First Officers constituted 55 percent of their losses. Newly hired pilots, those with three or less years at ExpressJet, constituted 38 percent of their losses. Of the 522 pilots who left ExpressJet in the first 8 months of 2014, 42 percent were listed as "Unknown" for the reason they left (Expressjet 2014).

This data indicates two recent trends. The first trend is an increased number of captains leaving for the majors, matching the trend of increased hiring at the majors. The second trend is an increased number of new-hire pilots (those with 3 or less years at ExpressJet) leaving for other minor airlines.

In a 2011 study by UND, *US Pilot Labor Supply*, the researchers queried recently graduated CFIs from 17 different university flight programs. Of the 117 participants, they averaged $73,016 debt remaining for their education and flight training (Lovelace and Higgins 2011). Additionally, 25.8 percent of the participants reported over $100,000 in financial aid debt remaining. This debt is significant when new pilots are entering a job market where salaries for their first 8 years (two at commercial or instructional node and the first six at the minors) will not exceed $50,000/year. Figure 2.2 displays the weighted annual salaries for pilots as they start their careers in the regional airlines carrying the extensive debt.

Figure 2.2. Weighted Annual Salaries for Top Majors and Regionals



SOURCE: Salary data (does not include additional pay such as international override or per diem, nor does it include any retirement benefits) for each of the top airlines built from airlinepilotcentral.com and audriesaircraftanalysis.com with the following assumptions:

Majors – United, Delta, American/US Air, FedEx, Southwest, UPS, JetBlue, Alaska. CY14 $, 75hrs/month (pay based on hourly wage), no Interest, no scheduled pay raises factored in.

Regionals – SkyWest, American Eagle/Envoy, ExpressJet, Republic, Endeavor. CY14 $, 80hrs/month (pay based on hourly wage), no Interest, no scheduled pay raises factored in.

Another UND study, *Pilot Labor Supply and the role of Universities in Flight Training* analyzed the distribution of over 1300 aviation students over the past ten years. Those majoring in a flight program fell from 75 percent of the total in 1999 to 55 percent in 2011. Air Traffic Control majors grew from 10 percent to 25 percent in the same period. Those majoring in an Unmanned Aerial Systems major grew from none before 2009 to 6 percent by 2011. Of their 120 CFIs who were hired in 2011, 53 percent were hired by the minor airlines, and 86 percent went into a professional flying career. This 53 percent number is in line with the results of their *Career Aspirations Study* that surveyed 271 aviation students, and found 56 percent desired a career with the airlines, though the survey did not ask whether their desire was to pursue a different professional flying path. This study also predicted a 38,178 shortage of pilots (supply compared with demand) by 2031 (Lovelace, Higgins et al. 2011).

3. Pilot Demand

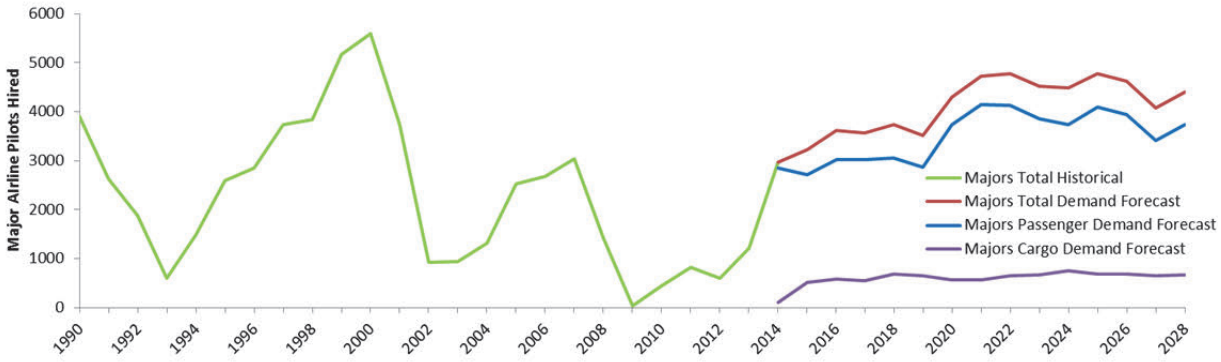
Using the methodology described in Chapter 1, this chapter summarizes the demand results for each node that were produced by the Pilot Flow (PF) Model. The sections are divided into demand for ATPs and commercial pilots.

Demand for ATPs

Majors

The following graphic displays the historic and forecast major airline hiring determined by the PF model.

Figure 3.1. Part 121 Majors, Historical and Forecast



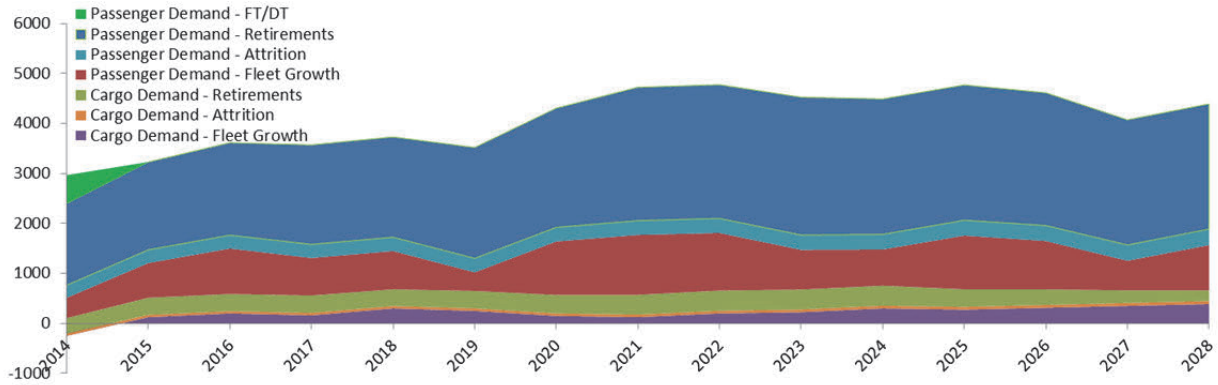
SOURCE: PF Model

Although the majors Passenger category consists of only 13 of the 82 Part 121 operators and the majors Cargo category consists of only seven operators, the majors is by far the largest category of ATPs consisting of 60.4 percent of the employed ATP population. The new pilot requirement is significant. By 2015, demand has surpassed 3000 new pilots/year, and by 2020 it passes the 4000 pilot/year threshold. The 15-year average is over 3900 pilots/year, creating uncharted territory for majors hiring of this duration. Historically, the industry has seen hiring spikes at these levels for three to four year periods[49], but has never experienced sustained hiring at these levels. Most of the future growth is in the passenger sector of the majors, with mandatory retirements driving the majority of growth followed by passenger fleet growth. Thus, even if the fleet growth prediction is cut in half, this still represents an unprecedented demand in

[49] Both in the late 1980s and the late 1990s.

scope and duration. Demand created by F/DT is significant, but this demand change ends after 2014, and is normalized into the baseline numbers.

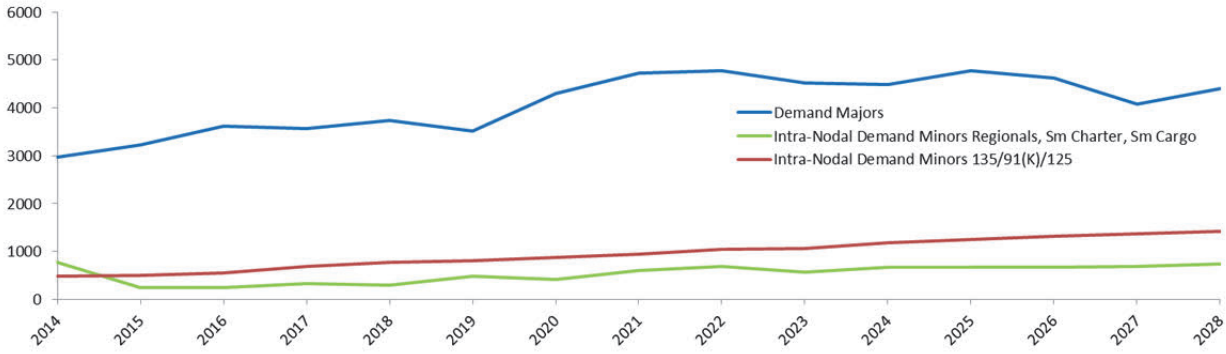
Figure 3.2. Part 121 Majors Demand



SOURCE: PF Model

Minors

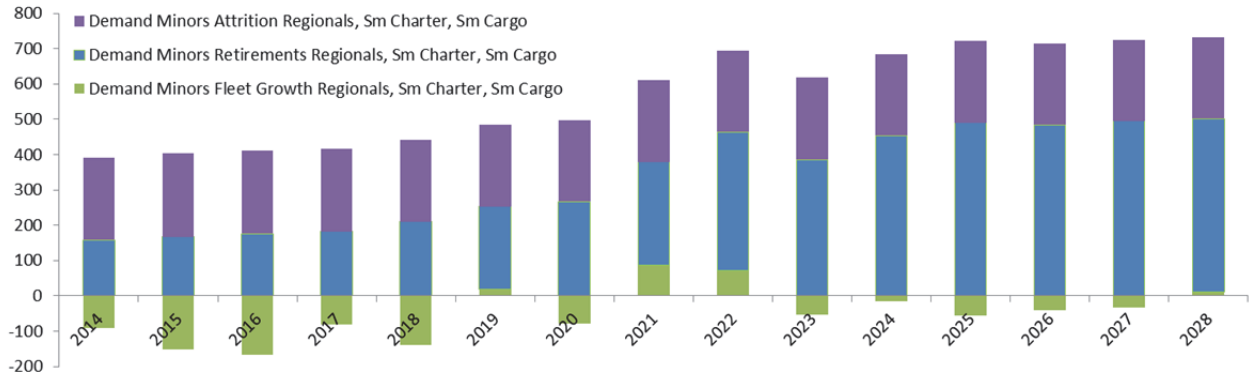
Figure 3.3. Intra-nodal ATP Demand – Part 121



SOURCE: PF Model

The minors node consists of Part 121 regionals, small charter, and small cargo and PICs in certain Part 135, Part 91(K), and Part 125 operations. There are approximately 20,000 fewer pilots in the minors node than the majors node it feeds. The time spent at this node is much shorter, on average, than at the majors. Demand for the minors node is also much smaller. This results from fewer retirements as a percentage, and stagnant forecast growth of Part 121 minors regionals fleets. Forecast numbers for Parts 135, 91(K), and 125 fleets shows significant growth throughout the study timeframe.

Figure 3.4. Part 121 Minors Intra-Nodal Demand – Regionals, Sm Charter, Sm Cargo



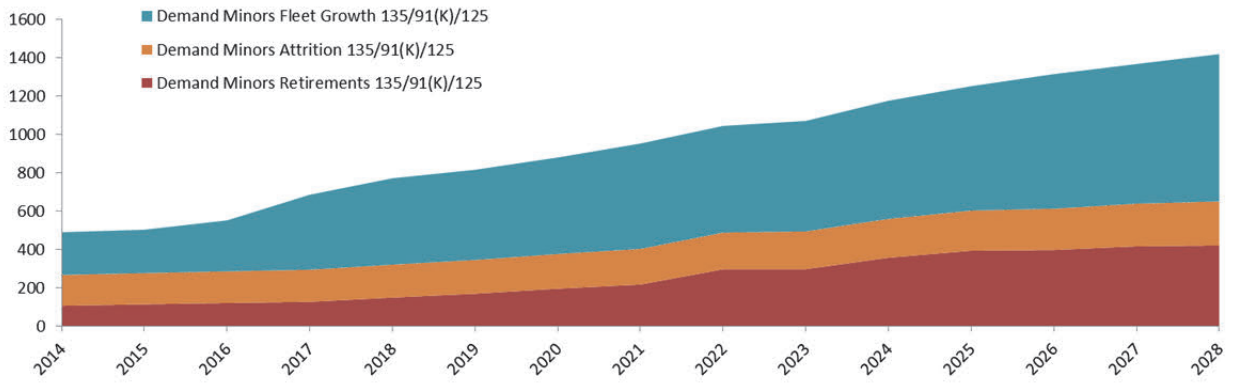
SOURCE: PF Model

The FAA forecasts the Revenue Passenger Miles (RPM)[50] for regionals, small charter, and small cargo operators will grow over the forecast period, but at a rate less than the majors. Although RPMs will grow, the overall fleet size will shrink (FAA 2014). It notes:

> Unlike the mainline carrier fleet, the regional carrier fleet shrank in 2013, falling by 127 units. Since reaching a peak in 2007, the US regional carrier fleet has been reduced by more than 20 percent (567 units). Consolidation among regional carriers and high fuel prices continue to spur retirements of 50-seat and smaller regional jets as well as small piston and turboprop aircraft.

These smaller 50-seat regional jets are being replaced by higher capacity 70- to 90-seat regional jets. While this node will continue to create a demand within the node because of retirements and attrition, fleet growth is not predicted to be a driver.

Figure 3.5. Other Minors Intra-Nodal Demand – Part 135/91(K)/125



SOURCE: PF Model

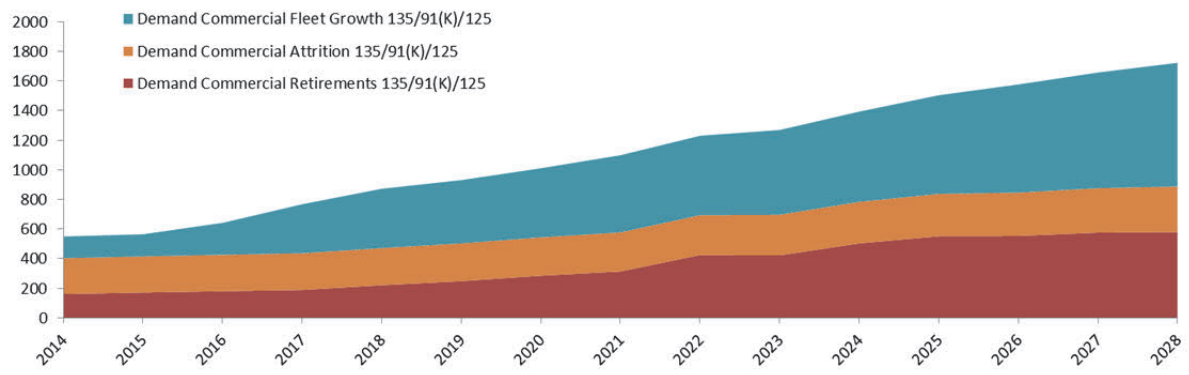
[50] RPM is a measure of traffic. Revenue paying passengers * trip miles.

The other portion of the minors Node is the ATP requirement within the Part 135, 91(K), and 125 operators. The majority of this demand is fleet growth in the larger charter and corporate fleets. According to the FAA, "The more expensive and sophisticated turbine-powered fleet is projected to grow to a total of 49,565 aircraft at an average rate of 2.6 percent a year over the forecast period, with the turbine jet portion increasing at 3.0 percent a year, reaching a total of 22,050 by 2034." (FAA 2014)

While the minors node is typically thought of as a "pass-through" node to the majors, many of the larger charter and corporate operations offer salaries and retirement benefits that rival the majors, and the retirement profile used will most likely underestimate the actual number. While these intra-nodal demand numbers are small compared to the majors, it does have an effect that must be captured on the number of future professional pilots required to offset the future demand.

Commercial Node

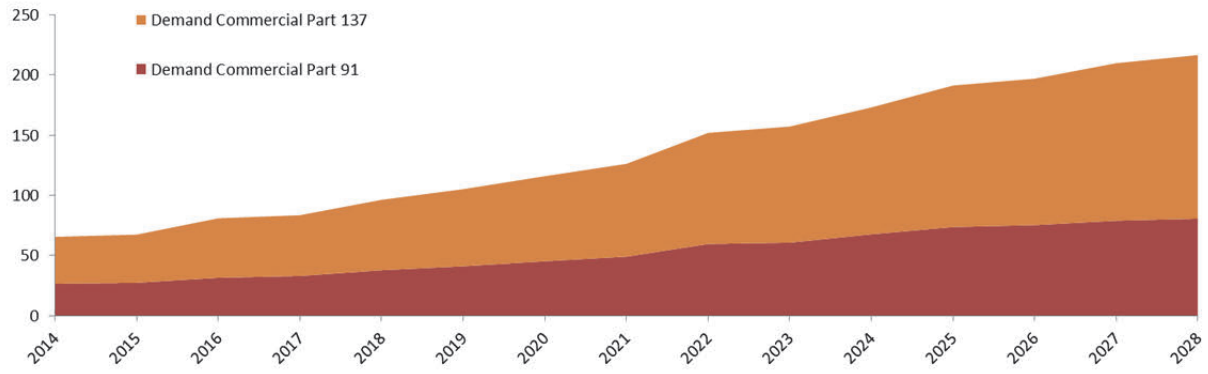
Figure 3.6. Commercial Intra-Nodal Demand – Part 135/91(K)/125/Corporate



SOURCE: PF Model

This breakout of the commercial node includes 1646 Part 135/91(K) operators and 94 Part 125 operators. This grouping includes the SIC pilots from the operations included in the Part 135/91(K) requiring ATPs and the Part 125 SICs. It also includes the PICs and SICs for the Part 135/91(K)s and corporate operators not requiring any ATP pilots (small aircraft). The forecast for this breakout of the commercial node is steady growth throughout the study period. While the forecast for the smaller aircraft in this node is stagnation (and contraction for small piston aircraft), the forecast for larger turbine aircraft is strong. The Part 135, 91(K), and 125 operators who operate larger turbine aircraft split between this node and the minors node. Most of the flow-through for these pilots will be within the same organization as they gain enough experience and an ATP certificate to upgrade into the left seat.

Figure 3.7. Commercial Intra-Nodal Demand – Part 91 and Part 137



SOURCE: PF Model

This breakout of the Part 91 commercial node includes 366 different fixed-wing operators. The size and scope of these operators varies significantly, from the Aviation Section of the U.S. Drug Enforcement Agency with 101 pilots and 63 aircraft to the University of South Carolina Athletics Department with two pilots and one aircraft. The forecast for this breakout is stagnant fleets and little influence on the system.

The breakout for agricultural aircraft is strong growth. "Increased demand, especially for agricultural use turboprop aircraft also contributes to increased turbine fleet and hours." (FAA 2014) There are 1505 different fixed-wing operators in this breakout. Almost half of these operators (723) fly with only a single aircraft.[51] The small relative numbers of aircraft and pilots in this breakout have little overall effect on the system.

Instructional Node

This node includes 455 Part 141 Training Centers. Approximately 33 percent are associated with a university, such as the Aviation Department at UND or Embry-Riddle Aeronautical University. The other approximately 66 percent range from large operations, such as US Aviation academy with over 80 aircraft, to small operations with just one aircraft.

Table 3.1. Part 141 Operators

Assoc with Univ	Total Inst	Avg Enroll	# AC	Flight Schools
N	3169	8489	2248	296
Y	3811	12129	1904	159
Grand Total	**6980**	**20618**	**4152**	**455**

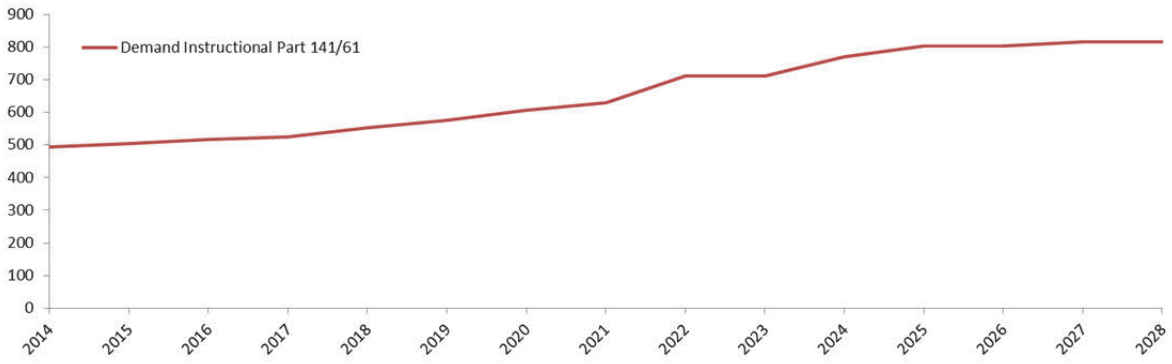
SOURCE: http://av-info.faa.gov/dd_sublevel.asp?Folder=%5CPilotSchools

[51] FAA Air Operator Information Table

Also included in this node are Part 61 operators instructing in 5379 aircraft. FAA tracking for Part 61 training operators is not nearly as detailed as it is for Part 141 operators because there is no annual reporting requirement for Part 61 operators as there is for Part 141 operators.

As is discussed in the dynamic model results in Chapter 5, this profile for the Part 141/61 node is only a starting snapshot. As the demand and supply interacts, it is assumed that this node reacts to the required demand. See Chapter 4 for more discussion.

Figure 3.8. Instructional Intra-Nodal Demand – Part 141 and Part 61 Operators



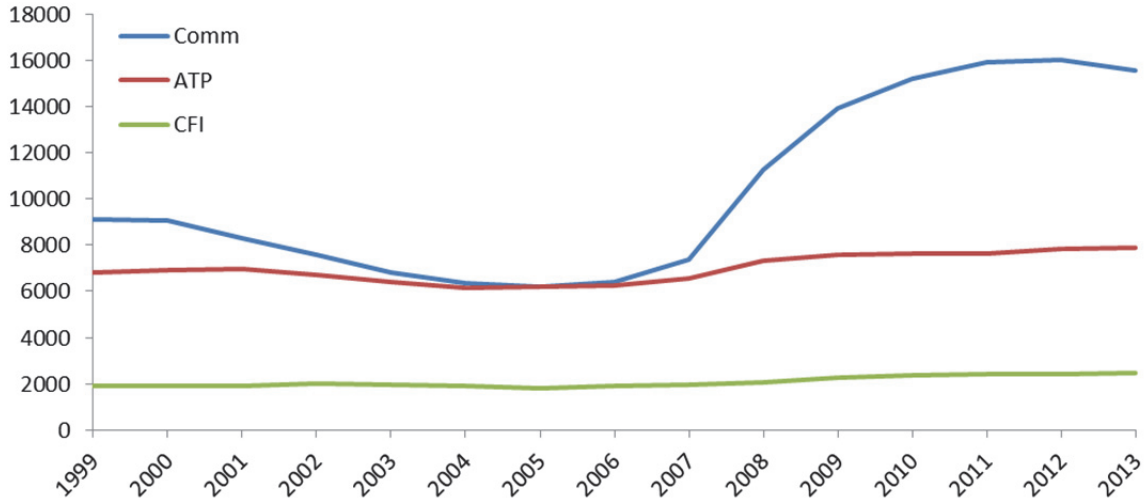
SOURCE: PF Model

International Node

Many studies have hypothesized about the large draw on the pipeline from foreign commercial or airline carriers. As noted before, there were only 3075 foreign-based pilots with a fixed-wing commercial certificate and a valid Class 1 or 2 medical and 3502 foreign-based pilots with a fixed-wing ATP certificate and a valid Class 1 medical who appeared in both the August 2013 and May 2014 releasable master FAA database. Another methodology was used check the validity of these data. The FAA publishes annual statistics on the numbers of "Active Pilot Certificates Held".[52] The following graphic displays these numbers from 1999-2013.

[52] http://www.faa.gov/data_research/aviation_data_statistics/civil_airmen_statistics/

Figure 3.9. Historic Number of Foreign-Based FAA Certificates



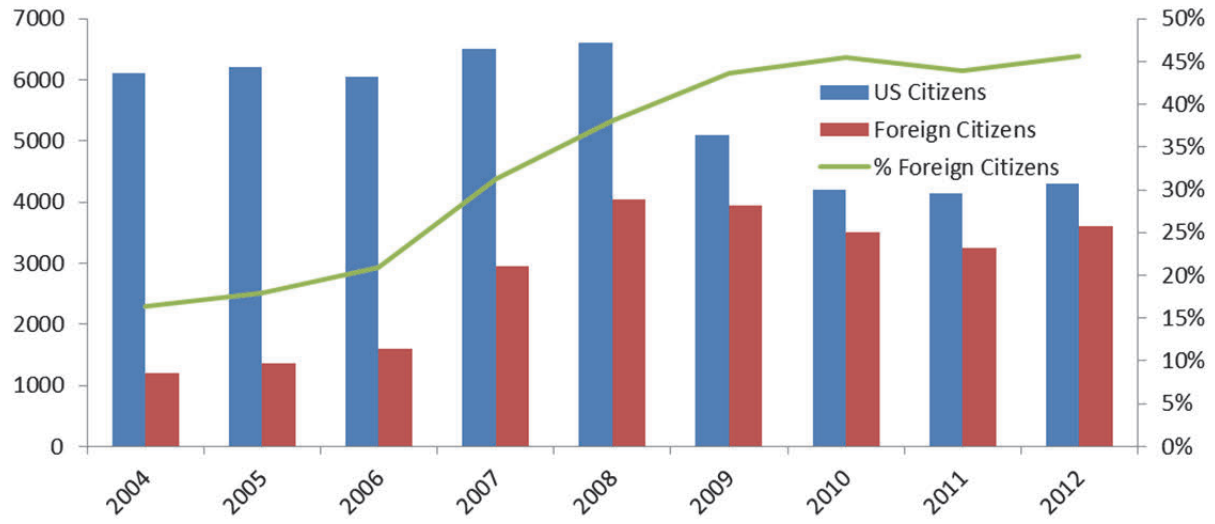
SOURCE: http://www.faa.gov/data_research/aviation_data_statistics/civil_airmen_statistics/

In the 14-year span between 1999 and 2013, the number of foreign-based CFIs has risen by only 599 pilots, and only 140 in the past four years. The number of ATPs has risen by only 1095 pilots, and by only 267 in the past four years. Neither of these indicates a recent change in U.S. pilot response to significantly increased international hiring. There has, however, been a sharp increase in foreign-based commercial certificates issued. Between 2006 and 2013, there was an increase of 9120 foreign-based commercial pilots. This increase seems significant until the number of foreign student attending U.S. flight schools is factored in. The 2013 UND study showed a high correlation between numbers of commercial written exams[53] taken and number of commercial certificates issued the following year.(Higgins, Lovelace et al. 2013) The number of foreign students taking the commercial written exam has jumped significantly in the past six years, now accounting for 45 percent of all the commercial written exams taken in the United States.[54]

[53] A prerequisite for obtaining a commercial certificate

[54] http://www.faa.gov/data_research/aviation_data_statistics/civil_airmen_statistics/

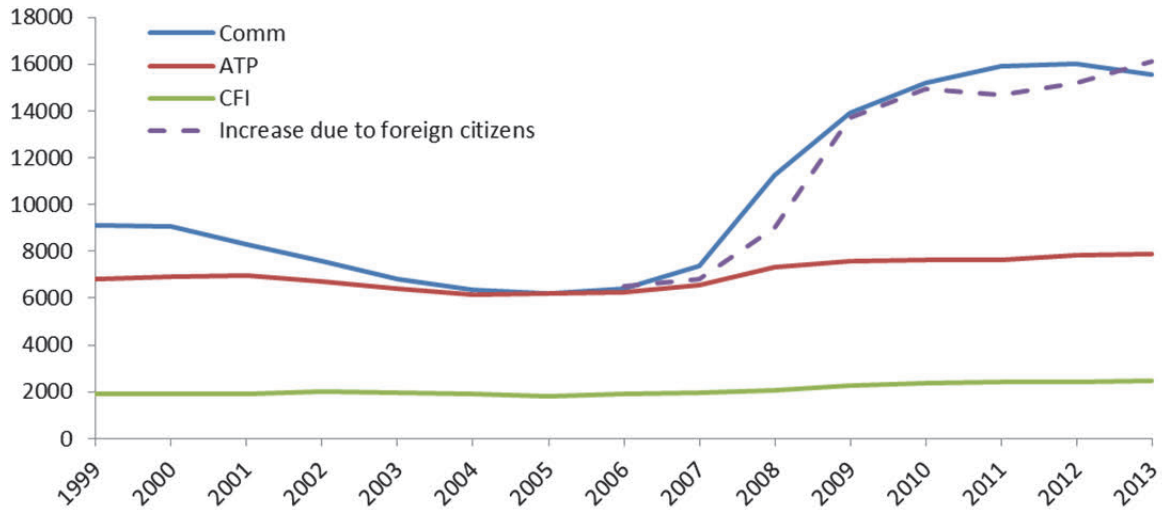
Figure 3.10. US and Foreign Citizen Commercial Written Exam



SOURCE:(Higgins, Lovelace et al. 2013)

Factoring in that this significant increase of foreign students who come to the United States to get their certification then return to their home country to fly,[55] this study concludes that the increase in foreign-based commercial certificates is attributable primarily to non-U.S. citizens.

Figure 3.11. Historic Number of Foreign-Based FAA Certificates with Foreign Citizens



SOURCE: PF Model

[55] Based on commercial written exams

While neither of these methodologies is conclusive, they do indicate there is not a current trend of significant numbers of U.S. pilots leaving the pipeline for foreign-based airlines. In fact, between 31 December 2013 and 01 October 2014, the number of all foreign-based commercial pilots licensed in the United States has dropped by 61.[56] In addition, the training bond for many foreign airlines ranges from three to five years.[57] Many young ATPs who choose to fly for a foreign air carrier instead of flying for a regional because of the higher pay and benefits will reenter the pipeline with the majors once their training bond[58] is complete and they have enough hours to be competitive for employment. In this case, the net effect on the pipeline in total is zero. While some pilots may choose to fly their entire career overseas for a foreign-based airline, the FAA data indicate those numbers are very low relative to the total population of the majors node, and thus do not affect the pipeline significantly.

---

[56] Table 5 at http://www.faa.gov/data_research/aviation_data_statistics/civil_airmen_statistics/2013/ versus http://registry.faa.gov/activeairmen/M70_Active_Pilots_Detail_Foreign.pdf pulled 04 October 2014

[57] https://www.emiratesgroupcareers.com/english/Careers_Overview/Pilot_Jobs/pilot_faq.aspx

[58] A training bond is typically an agreement between the pilot and the airline to pay for the initial training. The bond is satisfied when the pilot has flown for the airline for a specified period of time (usually 1-3 years).

4. Pilot Supply

Military and Minors to Majors

As discussed earlier, this model supplies the demand at the majors from two pools of pilots, the minors and separating/retiring pilots from the military. The forecast demand at the majors every year in the model timeframe is well above the potential supply coming from the military. This model also assumes that all military pilots desiring a career with the majors will find employment. In the first 8 months of 2014, 610 new pilots entered training for Delta Airlines. Of those pilots, 49 percent are prior military, even though less than 10 percent of the annual potential supply pool is prior military.(Delta 2014) In this study, the military supply is calculated first, and the minors supply is the difference between the total majors demand minus the pilots supplied by the military.

Military

Military pilots are supplied from the U.S. Air Force (USAF), the U.S. Navy (USN), the U.S. Marine Corps (USMC), and the U.S. Army (USA)[59]. The majority of fixed-wing pilots in the military are in the USAF, followed by the USN, the USMC, and then the USA. This model only considered fixed wing-pilots in the supply chain. Although some helicopter pilots will transition to professional fixed-wing careers, they are required to gain the same amount of fixed-wing experience as any other pilot to become competitive for employment. Thus, these pilots are captured where they will be required to gain their fixed-wing experience, in the civilian pipeline.

The following table lists the number of total and fixed-wing pilots in the different military services.

[59] Includes Active Duty, Guard, and Reserves. USCG also flies fixed-wing aircraft. This study did not have access to US Coast Guard (USCG) data. The USCG has only 79 fixed-wing aircraft, so the lack of this data will not significantly change the study results.

Table 4.1. Pilots – Military FY13[60]

Service	Total Pilots	Fixed-Wing Pilots
USAF RegAF	14015	13279
USAF ANG	3577	3512
USAF AFR	3288	3236
USN	7354	4052
USMC	4127	1798
USA	10195	1044
Total	42556	26921

SOURCE: (GAO 2014, HQDA 2014, OPNAV 2014, USAF/A1 and Bigelow 2014)

The majority, 89 percent, of fixed-wing pilots fly in the USAF or the USN. 74 percent of the fixed-wing pilots reside in the USAF, and 15 percent in the USN. Over half the pilots in the USMC fly rotary-wing aircraft, as do almost 90 percent of USA pilots.[61]

As discussed in the literature review, multiple studies have concluded that not only are military pilot losses highly correlated with major airline hiring, it is the most significant variable in predicting military pilot losses to the major airlines.

- The Air Force Institute of Technology (AFIT) study

  Predicted CCR[62] = - .011 * PilotHires + 76.893

- The RAND Pilot Retention study

  Predicted a 35 percent increase in separations for the USAF and an 11 percent increase for the USN for an increase of 2500 airline hires

- United States Air Force Academy (USAFA) study

  Every 1 percent increase in airline hiring increases the probability of separating by 1.13 percent for a given USAF pilot population

- Center for Naval Analysis study

  2.3 percent to 2.7 percent reduction in retention rates for jet and propeller pilots for every 1000-person increase in hires by the major airlines

"Exit surveys for the Air Force indicate that for those officers separating from the service, airline hiring is the number one factor in the decision to leave"(Dalonzo 1999).

---

[60] There are approximately 340 fixed-wing pilots in the Naval Reserves and 210 fixed-wing pilots in the USMC Reserves. These pilots are not included in the military pilot totals nor the pipeline because of lack of credible data.

[61] This study did not have access to US Coast Guard (USCG) data. The USCG has only 79 fixed-wing aircraft, so the lack of these data will not significantly change the study results.

[62] CCR is cumulative continuation rate, the percent of pilots in the 6-14 years of service who stay in the military

These previous studies have found a significant correlation between major airline hiring and USAF and USN losses. The previous RAND study found no significant correlation between USMC pilot losses and airline hiring. The results of this dissertation agree with the four studies listed above.

In this study, annual pilot loss and separations data for the USAF RegAF, ANG, AFR, and the pilot loss for the USN showed a significant relationship to major airline hiring; the annual pilot loss data from the USMC and the USA did not show a significant relationship. The fixed-wing pilot pools for the USMC and USA are relatively small, and their losses do not have a significant effect on the supply to the major airlines.

Military pilot losses are categorized into the following groups[63]:

1. Separations - those pilots who leave the military before 20 years of service
2. Retirements - those pilots who leave the military after 20 years of service
3. Promotion - once pilots are promoted to the rank of O-6/Colonel/Captain, they are no longer counted in the pilot inventory
4. Grounded - those pilots who have lost their flight status because of such reasons as loss of medical clearance
5. Other - deaths and other losses that had insufficient data to broadly categorize

The potential pool of military pilots for major airlines includes the annual separations and retirements. A significant relationship was found between MAH and the number of annual separations in the USAF, the combined total of USAF separations and retirements, the total USAF losses, ANG total losses, AFR total losses, and USN total losses. MAH also explained a significant proportion of variance in these outcomes. The following table summarizes the regression results found in Appendix E.

Table 4.2. Regression Results, Military Pilot Losses versus MAH

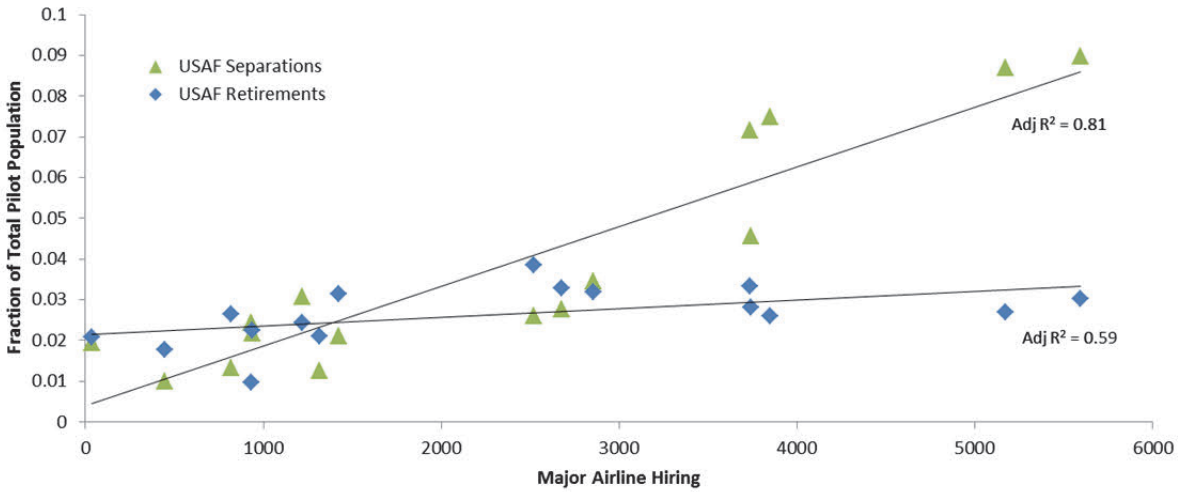
Versus MAH	*Adj* R^2	β	*t*	*p*
Total USAF Losses	.88	1.617E-05	(16) 10.04	<.001
USAF Separations and Retirements Combined	.90	1.637E-05	(16) 11.76	<.001
USAF Separations	.81	1.402E-05	(16) 8.74	<.001
USAF Retirements	.59	2.355E-06	(16) 2.72	.015
Total AFR Losses	.56	1.191E-05	(14) 4.35	<.001
Total ANG Losses	.61	9.217E-06	(15) 4.79	<.001
USN Fixed-wing Losses	.78	1.402E-05	(14) 7.39	<.001

[63] The Air Force Personnel Center annual Rated Retention Report.

SOURCE: PF Model

The scatterplot of USAF separations and retirements follows. Although retirement numbers rise slightly with increased major airline hiring, separations account the vast majority of losses at higher levels of major airline hiring.

Figure 4.1. Scatter Plot of Separations and Retirements vs Major Airline Hiring[64]

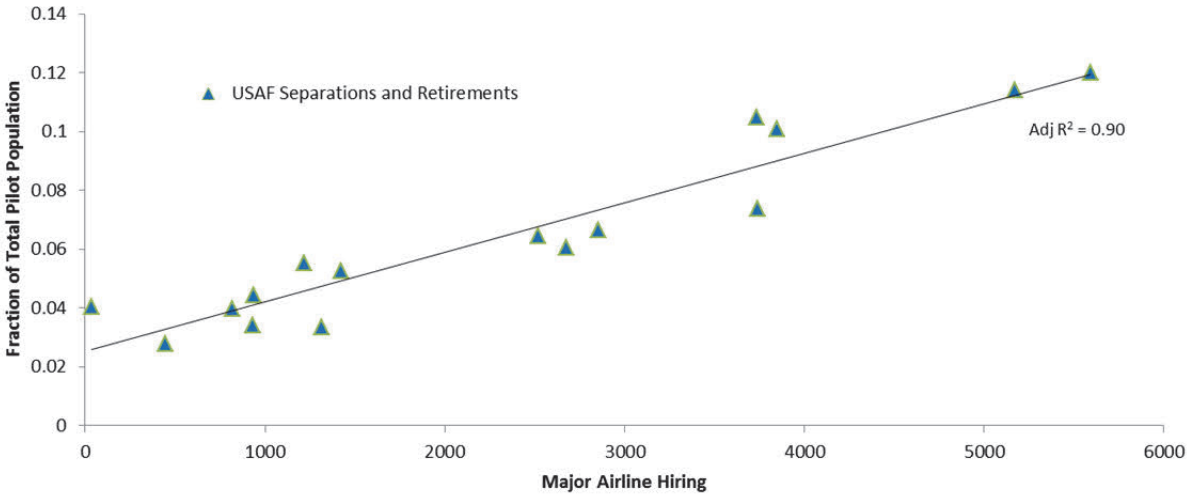


SOURCE:(AFPC/DSYA 1997-2013)

Interestingly, in years that separations are above the trendline, retirements tend to be below the trendline and vice versa. At very high MAH, pilots separate at a rate slightly higher than the linear relationship models, and retire at a rate slightly lower than the linear relationship models. The following graphic depicts separations and retirements combined compared with major airline hiring, and the relationship is even stronger.

[64] Both control for force shaping years as is done later in the analysis.

Figure 4.2. Scatter Plot of Separations and Retirements Combined vs Major Airline Hiring[65]

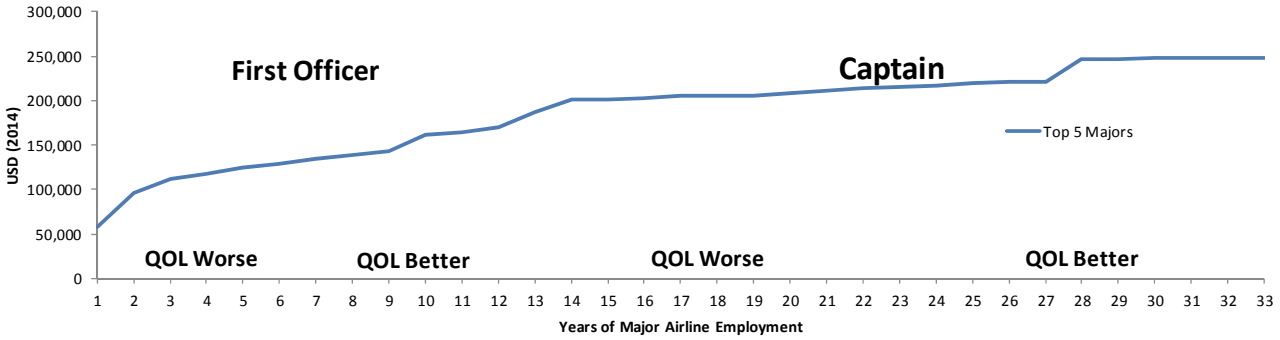


SOURCE:(AFPC/DSYA 1997-2013)

Most military pilots who desire a career with the airlines separate at the end of their ADSO, instead of waiting until retirement. Two important factors when considering employment at the major airlines are the financial benefits and quality of life (QOL). One of the products of the airline seniority system is that the more senior pilots at both the first officer and captain levels get to bid first on flights. That means the junior pilots must accept the weekend, holiday, and red-eye flights. The more senior pilots experience a better QOL in that they get to choose when they want off for family functions, vacations, and holidays. This element is depicted on the following graphic. The displayed salary (no retirement or other benefits included) and upgrade timing is a weighted average of Delta, United, American/US Air, Southwest, FedEx, UPS, JetBlue, and Alaska.

[65] Controls for force shaping years as is done later in the analysis.

Figure 4.3. Majors Salaries and QOL



Age of Mil Pilot Who																																
Separates	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65
Retires	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65								

SOURCE: Salary data (does not include additional pay such as international override or per diem, nor does it include any retirement benefits) for each of the top airlines built from airlinepilotcentral.com and audriesaircraftanalysis.com with the following assumptions:

Majors – United, Delta, American/US Air, FedEx, Southwest, UPS, JetBlue, and Alaska. CY14 $, 75hrs/month (pay based on hourly wage), No Interest, No scheduled pay raises factored in.

Regionals – SkyWest, American Eagle/Envoy, ExpressJet, Republic, and Endeavor. CY14 $, 80hrs/month (pay based on hourly wage), No Interest, No scheduled pay raises factored in.

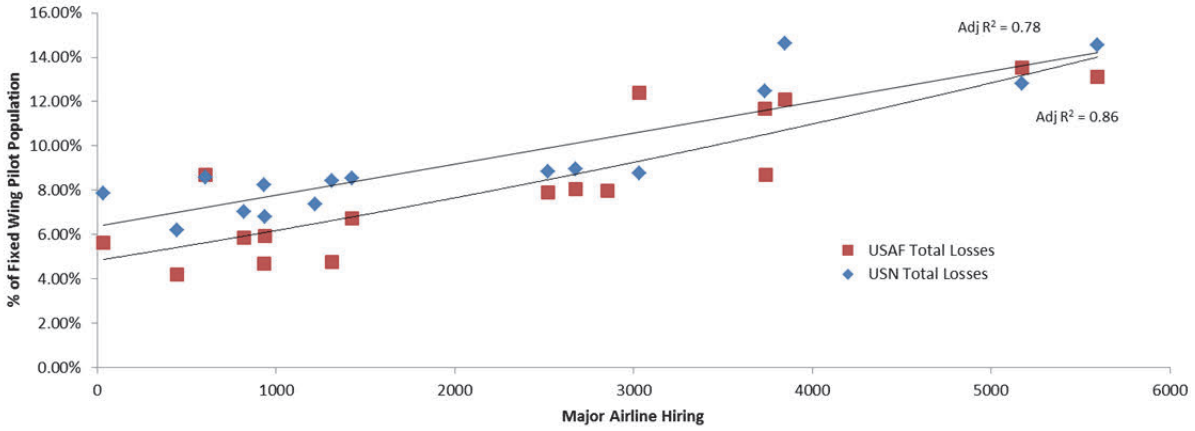
A military pilot who separates at age 33 begins the higher pay scale of a captain around age 45, and enjoys both a substantial salary and improved QOL in their 50s and 60s (to include reaching the highest salary plateau). A military pilot who retires does not join the majors until age 41 at the earliest. They will not reach the higher pay scales until their early 50s, and will not benefit from seniority as a captain (better QOL) until their 60s. They will never reach the highest salary plateau. As hiring accelerates, these benefits of seniority will shift to the left, but the concept still holds.

For the USN, this study only had total numbers of annual losses, so the study was unable to separate out the different types of losses: resignations (similar to separations in the USAF), retirements, and lateral outs[66]. The combined data for both the USAF and the USN still indicated a significant relationship to major airline hiring.[67]

[66] Lateral out occurs when a pilot transfers to another career field after completion of their Active Duty Service Obligation (ADSO) they incur after graduating from pilot training

[67] Regression results are included in Appendix E

Figure 4.4. Scatter Plot of Total USAF and USN Losses vs Major Airline Hiring



[68]

SOURCE:(AFPC/DSYA 1997-2013, OPNAV 2014)

Both sets of data indicate that USAF and USN pilots react to increased major airline hiring. This makes sense in that by separating from the military, the pilot is giving up lifetime military retirement benefits (pay and healthcare).[69] At lower major airline hiring, employment with the major airlines is not guaranteed, and many pilots compete for a given number of open jobs. 2009 and 2010 are examples of such years, when the major airlines hired less than 500 pilots/year. In other years, such as 1999 and 2000, major airline hiring was very high, averaging close to 5000/year. The chances for employment were much higher for a separating military pilot during these elevated hiring years, so the decision to give up those future benefits is offset by the high probability for future major airline benefits.

The difference in the loss rates for the USN and the USAF can be attributable to the difference in service pilot accounting and professional development. The USAF and USN are unique services with different warfighting roles and force structure, thus requiring different pathways for personnel development. The USN data includes Lateral Outs, which occurs when a pilot transfers to another career field after completion of ADSO. Between 2012 and 2014, approximately 1.5 percent of pilots in the USN were counted as "Lateral Outs". This difference can account for the higher loss rates in the USN.

It is notable that the data between the two services are so similar (r = .84). These two different services, with two different populations of pilots, flying different types of aircraft, with different deployment rotations, different professional development, and different financial

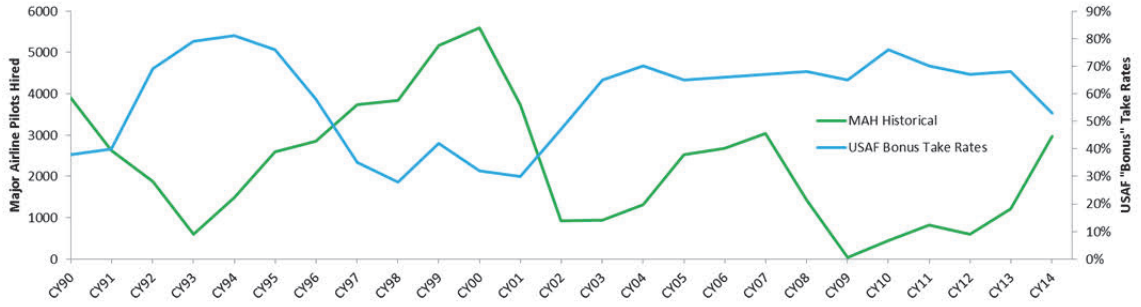
[68] FY07, FY12, and FY14 were force shaping years for the USAF, meaning it offered VSB, TERA, or conducted a reduction-in-force (RIF) board to selectively downsize the force (AFPC/DSYA 2013). These artificially affect the correlation of the data between separations and airline hires. For example, in 2012, 199 pilots were involuntarily separated through the RIF board (Ricks 2011).

[69] The pilot can still gain these retirement benefits (though slightly modified) by affiliating with the Guard or Reserves after separating and earning enough service time to qualify for these benefits.

incentives (discussed below) to stay in, experience strikingly similar reaction to major airline hiring.

During the late 1980s and into the early 1990s, there was a significant increase in major airline hiring and increase in AF and USN pilot separations. In an attempt to combat the loss of pilots to the airlines, the military introduced an Aviation Retention Pay (ARP) in 1989.[70] The original ARP offered $12K/year "bonus" if pilots signed up for an additional seven years at the expiration of their seven-year pilot training ADSC. The thought was that if the services could keep a pilot until 14 years of service, they would stay the extra six years until reaching the 20-year retirement mark. The take-rate for the bonus when major airline hiring remained high in 1990 was only 38 percent. In 1991, the first Gulf War occurred, major airline hiring slowed, and there was a corresponding increase in take rate. In 1997, major airline hiring once again increased above 3000 pilot/year. USAF and USN fixed-wing pilot separations again increased above the equilibrium level, and total inventories of pilots dropped below the requirement. In 1998, the "bonus" was increased to $22K/year bonus with variable contract amounts depending on the length of the contract. The "bonus" take-rate in the USAF was 28 percent. In FY00, with AF pilot separations continuing at unacceptable high levels, the "bonus" was increased to a maximum of $25K/year with the ability to accept 50 percent up-front capped at $100K. Additionally, the post-pilot training ADSC was increased to 10 years for newly graduating pilots. The "bonus" take-rate was only 32 percent. In FY01, the 50 percent up-front option was increased to $150K. The "bonus" take-rate dropped further to only 30 percent.

Figure 4.5. USAF Bonus Take Rates vs Major Airline Hiring



[71]

SOURCE:(AFPC/DSYA 1997-2013)

After the attacks on 9/11, major airline hiring dropped significantly, and major combat operations began in Afghanistan later that year and in Iraq two years later. Through the mid- to

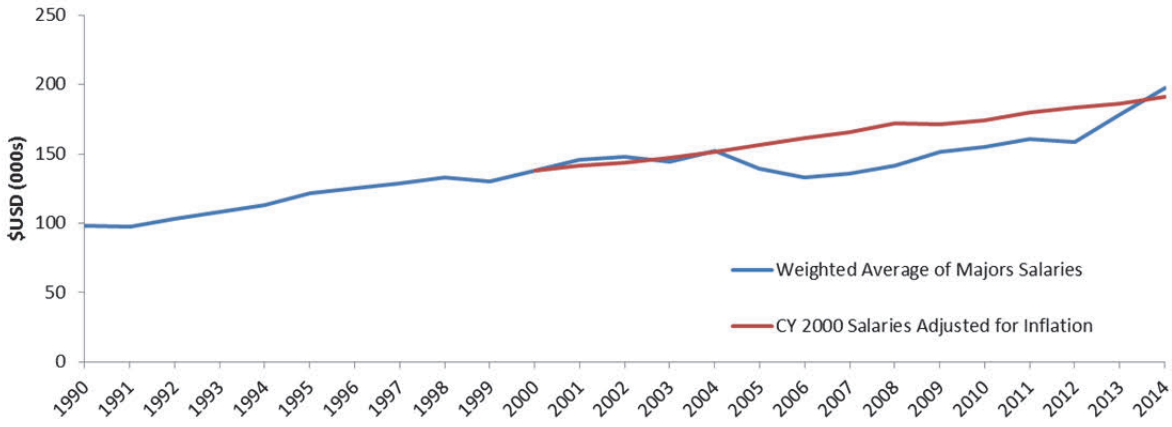
[70] See Appendix C for a complete history of the ARP/ACP.

[71] Major airline hiring is measured by calendar year, and USAF bonus take rates are measured by fiscal year, but for this graphic, this study considers this 3 month difference insignificant.

late 2000s, major airline pilot salaries dropped significantly as most of the major airlines went through a series of bankruptcies and restructuring. Pilot contract renegotiations including this period often included salary concessions. As major airline salaries plummeted and major airline hiring decreased, the "bonus" take-rate increased to an average of 68 percent between 2002 and 2013.(AFPC/DSYA 1997-2013) The major airlines recovered from the 9/11 shock and the economic downturn of the late 2000s, and major airline salaries began to rise again. During pilot contract negotiations, the earlier agreed-upon cuts in salaries were reversed. In 2014, these salaries for the major airlines have been restored equivalent to the year 2000 levels[72], as seen in the following graphic. Even more significant pay increases for major airline pilots are on the horizon. Delta pilots will receive approximately 15 percent of their salary as a profit-sharing bonus in December 2014 as part of their current contract.[73] In December 2014, American Airlines president Scott Kirby outlined the current offer to their pilots under the current contract negotiations[74] stating:

> Our offer now includes a pay scale that provides pilots with increases of approximately 23 percent upon signing…Under the offer, this initial pay increase would be followed by an annual 3 percent increase every January from 2015 through 2019.

Figure 4.6. Historic Majors Salaries



SOURCE: DOT Schedule P-5.2 and Schedule P-10. 2014 annual salary data is an extrapolation of 3Q14 data.

Annual USAF separations averaged 1106 pilot/year, or 8.4 percent of the total pilot population, between FY98 and FY00 when MAH peaked in the late-1990s (AFPC/DSYA 1997-2013). Annual USN fixed-wing separations averaged 534 pilots/year (OPNAV 2014). When

---

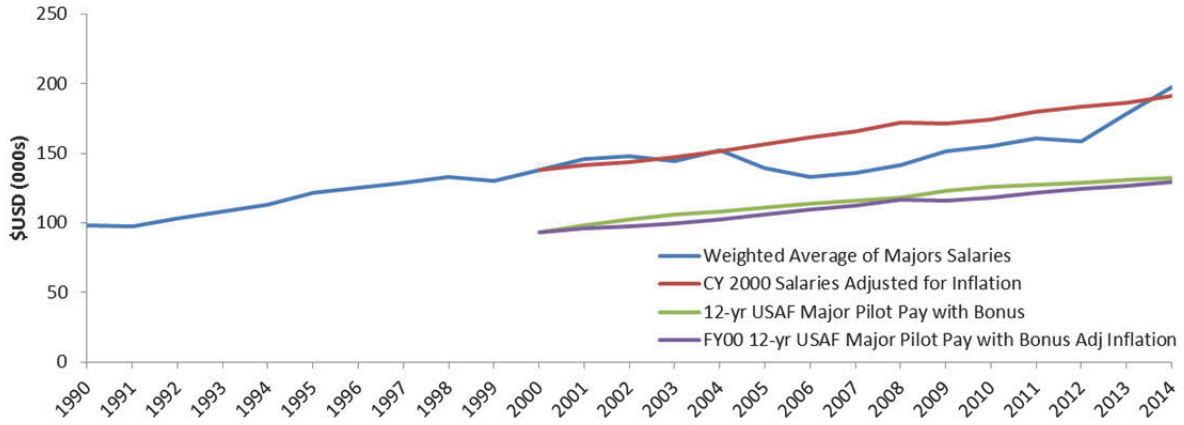
[72] Adjusted for annual CPI changes.

[73] http://www.wsj.com/articles/american-pilots-union-said-it-will-counter-managements-contract-proposal-friday-1415993421

[74] http://aviationblog.dallasnews.com/2014/12/american-airlines-inc-employees-to-get-4-percent-pay-raises.html/

MAH dropped between FY02 and FY11, annual USAF separations dropped to an average of only 267 pilots/year, or 2.0 percent of the total pilot population[75](AFPC/DSYA 1997-2013). Annual USN fixed-wing separations dropped to an average of 310 pilots/year (OPNAV 2014). The drop was the result of a number of factors, including decreased major airline salaries relative to the late 2000s, significantly decreased major airline hiring, increased military pay and benefits, and an increase in the sense of duty/patriotism post-9/11. Most of those factors are no longer in play. Major airline hiring is increasing significantly, and major airline salaries have recovered to levels equivalent to CY2000 adjusted for inflation. Military pay and benefits for pilots have kept pace with inflation, but the relative increase compared to major airline salaries has disappeared. Tangible military pay and benefits includes base pay, basic allowance for housing (BAH), basic allowance for subsistence (BAS), Aviation Career Incentive Pay (ACIP), and Aviation Continuation Pay (ACP). The following chart plots the pay and benefits for a major in the USAF with 12 years of service who accepted the ACP or the "bonus". While the military pilot's basic pay has increased by 63 percent from FY00 to FY14, the total pay and benefits for pilots has basically tracked equivalent to CPI increases because ACIP and ACP have remained unchanged since FY00.

Figure 4.7. Historic Majors Salaries and Historic USAF Major Pilot Pay



SOURCE: http://www.dfas.mil/militarymembers/payentitlements/militarypaytables.html. DOT Schedule P-5.2 and Schedule P-10. 2014 annual salary data is an extrapolation of 3Q14 data.

This study concludes the separation probability for those desiring a career with the airlines has returned to the levels of the late-1990s.

The linear regression equations[76] for USAF separations are inputs to the Total Force Blue Line (TFBL) model developed by Dr. Jim Bigelow at RAND. This model is a companion model

[75] Not counting FY07, which was a force shaping year.

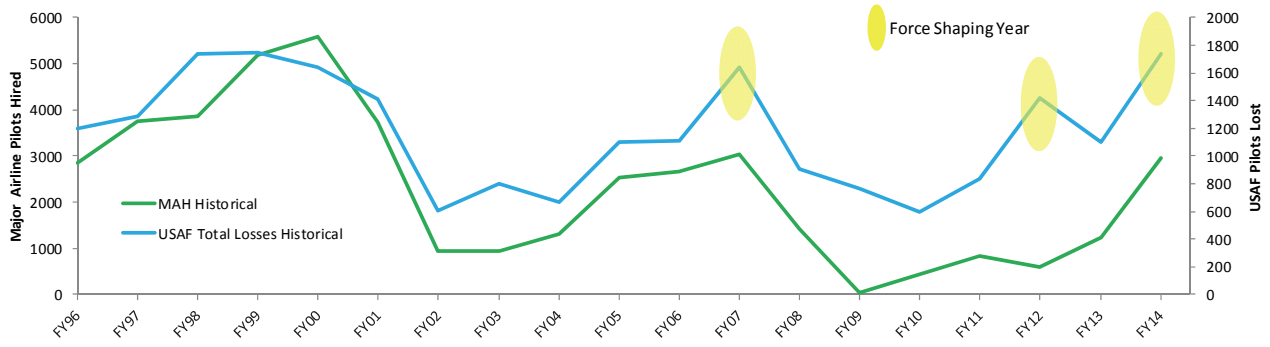
[76] Regression results are included in Appendix E

for Air Force Rated Aircrew Management System (AFRAMS). The TFBL model uses inputs from the following sources to forecast future USAF pilot inventory:

- Monthly manning files containing every member of the USAF (data is sanitized) provided by Air Force Personnel Center as part of Project Air Force (1980-present)
- Current Air National Guard manning provided by the ANG
- Current Air Force Reserve manning provided by the AFR
- Official active-component red line and blue line provided by HQAF/A1
- Historical and projected pilot production provided by AF Air Education and Training Command
- FY16 Program Objective Memorandum (POM) Graduate Program Requirements Document

The linear regression equations[77] for total USAF losses and separations and retirements are also inputs to the PF model as an alternate calculation to the TFBL model. Both models control for years with force shaping by the services. Force shaping occurs when the services deem they have too many pilots or too many pilots in a given mission area (such as mobility). Force shaping can include reductions-in-force (RIF), voluntary separation pay (VSP), and temporary early retirement (TERA). Force shaping makes separation and retirement numbers artificially high. Both models include control variables for years with force shaping, including FY07, FY12, and FY14.[78] The following demonstrates how total losses differ from the norm during force shaping years.

Figure 4.8. Historic USAF Pilot Losses



SOURCE: PF Model

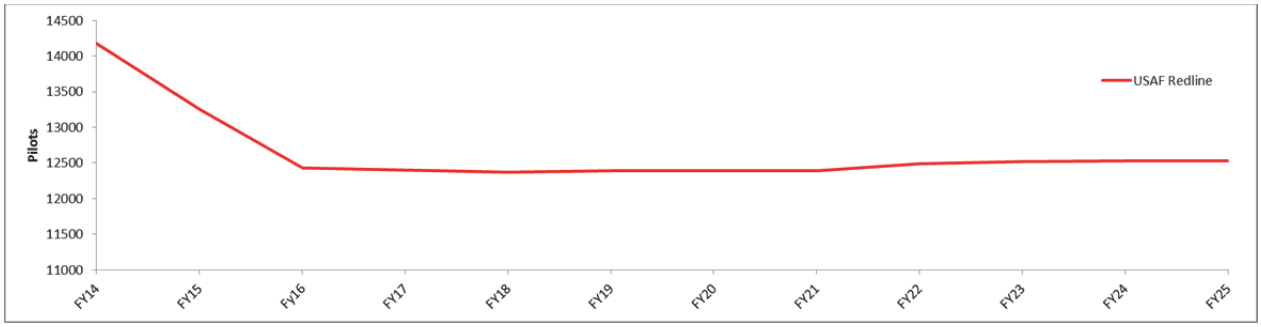
[77] Regression results are included in Appendix E

[78] FY07, FY12, and FY14 were force shaping years for the USAF, meaning it offered VSB, TERA, or conducted a reduction-in-force (RIF) board to selectively downsize the force (AFPC/DSYA 2013). These artificially affect the correlation of the data between separations and airline hires. For example, in 2012, 199 pilots were involuntarily separated through the RIF board (Ricks 2011).

These USAF pilot outputs (RegAF, ANG, and AFR) are used as the eventual supply for the majors node in the model. The total population of the ANG and AFR is reduced by the prior service population since those pilots are already counted in the separating or retirement numbers from the RegAF. Between 1990 and 2011, 53.5 percent of ANG pilot accessions were prior-service, as were 78.2 percent of the AFR accessions (Mele 2012). The USN outputs were modeled similarly. As discussed earlier, a 75 percent major airline affiliation rate is used for separating military pilots, and a 25 percent major airline affiliation rate was used for retiring pilots from the military. A historical weighted average is applied to approximate the size of the separation and retirement pools from the overall numbers. The USMC and USA fixed-wing outputs are minimal compared to the USAF and USN, but are calculated similarly to the USN. It is acknowledged that these forecasts of future military pilot outputs probably underestimate the potential supply because: 1) helicopter pilots are not included; and 2) USCG fixed-wing pilots are not included.

As discussed earlier, the RL (see Figure 4.8) represents the pilot requirements in the USAF. It is published annually by HQAF/A1, and reflects current pilot inventory requirements based on current planned future force structure. Currently, the total inventory of USAF pilots is greater than the total requirement. The excess is primarily in the mobility forces. The USAF is currently in the process of force shaping as it divests itself of the entire A-10 fleet and decreases the mobility pilot inventory to match the requirements.

Figure 4.9. USAF RegAF RL as of Sep 2014



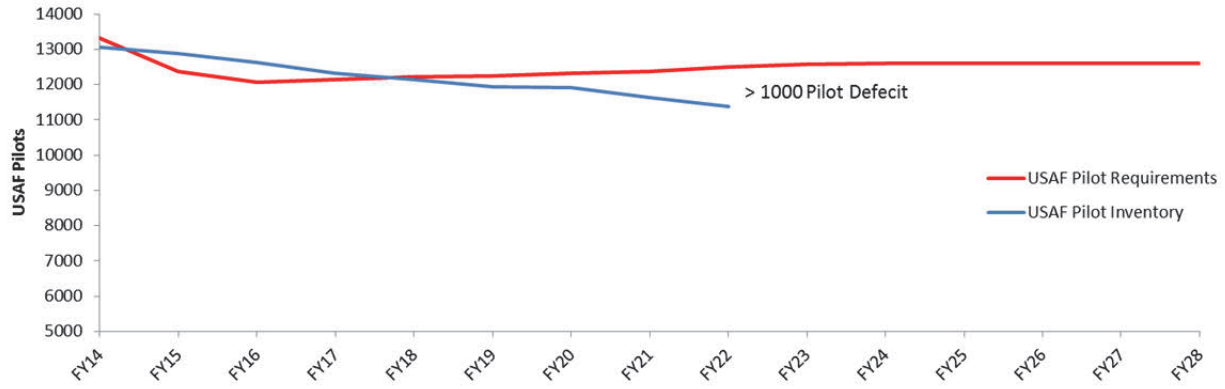
SOURCE: (USAF/A1 2014)

Between 2014 and 2016, the RL drops by over 1700 pilots. The RL then levels off just under 12400 pilots until FY21, when it increases slightly above 12500 as numbers of F-35As become operational to replace the lost A-10 fleet. The USAF is currently implementing force shaping programs to bring the pilot inventory down on a trajectory to meet the future RL.

The RAND TFBL model results are shown below in Figure 4.7. The model shows a significant pilot inventory drop in 2014 due to force shaping, then a downward slope because of higher-than-planned pilot losses as a result of major airline hiring. The BL drops below the RL in 2018, and continues on the downward trajectory until the BL is forecast pilot inventory (BL)

drops significantly through FY14 and FY15 due to planned Force Shaping. Once the force shaping program is complete in FY15, the model forecasts that the inventory continues on a downward trajectory until it drops more than 1000 pilots below the requirement in FY22 because of increased airline hiring driven separations.

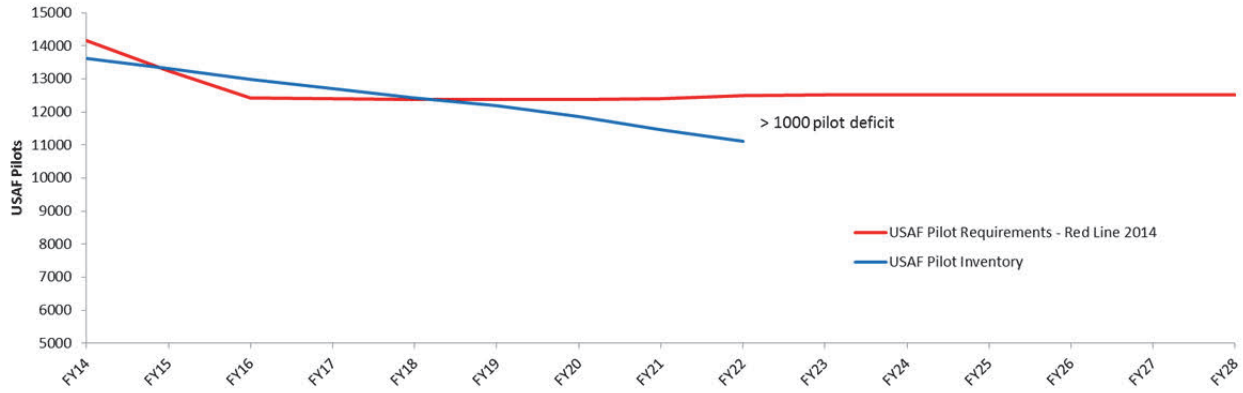
Figure 4.10. RAND TFBL Model Results



SOURCE: (USAF/A1 2014, USAF/A1 and Bigelow 2014)

The TFBL model was run with the 2013 official RL. In September 2014, the USAF accomplished its annual AFRAMS data run. This updated data includes a new Red Line and new pilot production numbers. The PF model was run using this updated RL and updated pilot production numbers.

Figure 4.11. PF Baseline Model Results

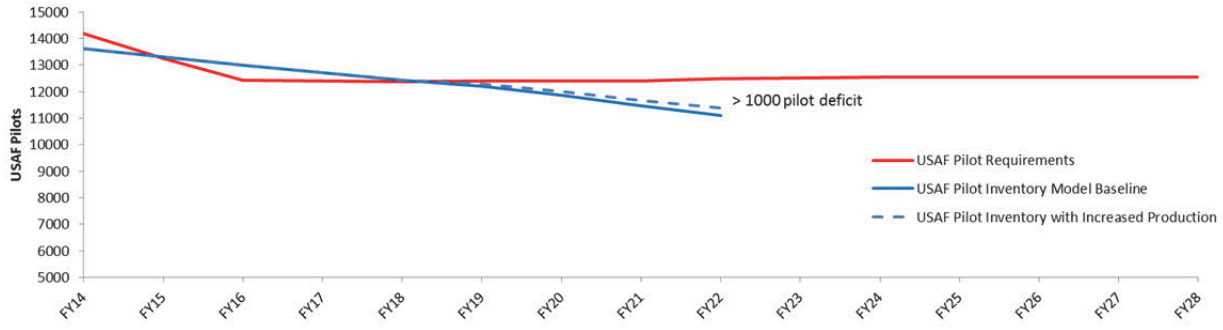


SOURCE: PF Model

The results of the PF model run are similar. Both models had a stop trigger at >1000 pilot deficit, assuming the USAF would implement some policy option at some point before the pilot inventory dropped this far below the requirement.

The PF model was also used to determine the policy options available to the USAF. The first option explored was the effect of increasing pilot production. Though this option does not stem the losses of experienced pilots leaving and creates an imbalance between inexperienced and experienced pilots, it is an option the USAF has complete control over. In FY14, pilot production is planned at 895 pilots, increasing to 983 in FY15, and 1023 for FY16 and beyond. For this increased production iteration, the pilot production was increased from the planned 1023 pilots/year to 1100 pilots/year[79] starting in FY19.

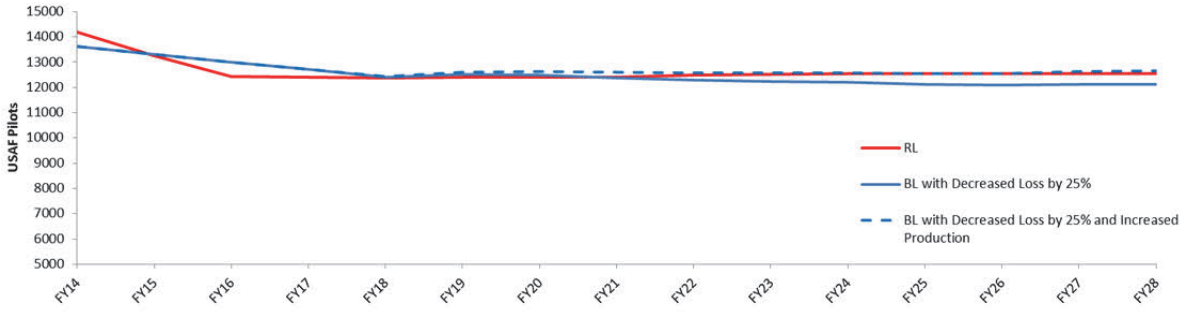
Figure 4.12. PF Model Results – Increased Production



SOURCE: PF Model

Even with increased production, the >1000-pilot deficit still occurred by FY22. The second policy exploration run focused on implementing changes at FY19 when the Blue Line met the Red Line. By implementing policy measures that cut predicted total losses by 25 percent starting in FY19, Figure 4.13 shows the majority of the pilot deficit is eliminated. Adding these measures to with an increase in pilot production to 1100 pilots/year, the pilot deficit disappears.

Figure 4.13. PF Model Results – Increased Production

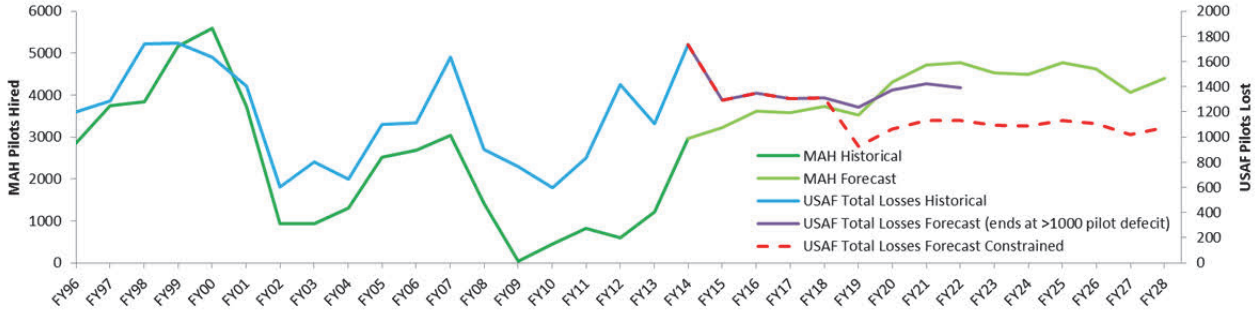


SOURCE: PF Model

[79] Upper bound of RegAF pilot production possible with current force structure per HQAF TFAM

The following figure compares historical USAF pilot losses with the PF model prediction, both with and without the policy-induced corrections and constraints. The model predicted losses are comparable to historic losses when major airline hiring was very high. The difference in this scenario is the unprecedented duration of predicted high major airline hiring.

Figure 4.14. USAF Pilot Losses – Historic vs Forecast[80]



SOURCE: PF Model

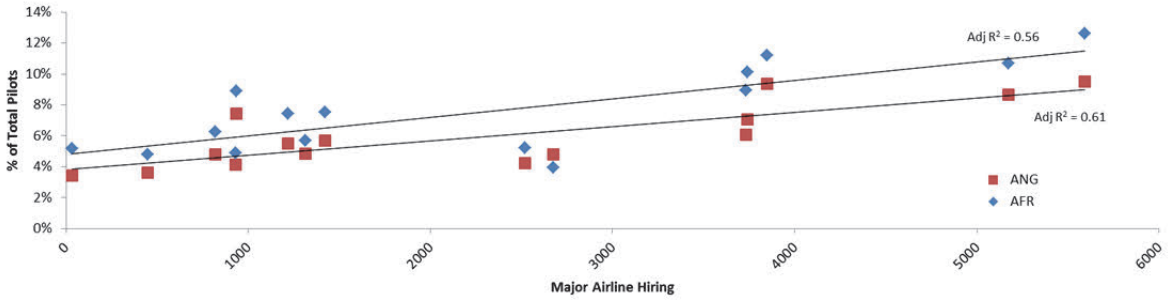
One issue with the data is the high standard error in the regression. There is approximately a 10 percent standard error in both the slope and the intercept of the linear regression. This equates to just below ± 300 pilots/year between the upper and lower bounds at 95 percent confidence level. The range drops to ± 150 pilots/year at 75 percent confidence level. This uncertainty is addressed in the following conclusions chapter.

The PF model artificially constrains the Air Force pilot losses at FY19 and beyond, assuming the USAF will implement policy changes to keep the inventory from falling significantly below the requirement. With no significant policy changes, the model predicts the USAF inventory will drop below the requirement and will continue to fall, eventually dropping >1000 pilots short of the pilot requirement by FY22. It is assumed that with a reduced pilot inventory after the FY14 force shaping and the divestiture of the A-10 fleet in FY15, significant gaps between the pilot inventory and requirement will not be tolerated. The military services have many policy tools at their disposal, from significant financial incentives to implementing temporary stop-loss of separations.

The Guard and Reserves also lose full-time pilots to the major airlines, albeit at a slightly lower rate than the RegAF at high levels of major airline hiring. A majority of part-time Guard and Reserve pilots already fly for the major airlines, so this lower loss rate is expected.

[80] USAF Total losses forecast stops at FY22 because the pilot deficit with no policy changes is expected to rise above 1000 pilots. By FY 26, the prediction with no policy changes is >2000 pilot deficit. This study assumes the USAF would never allow the pilot deficit to extend beyond 1000 pilots, thus it is an unrealistic scenario.

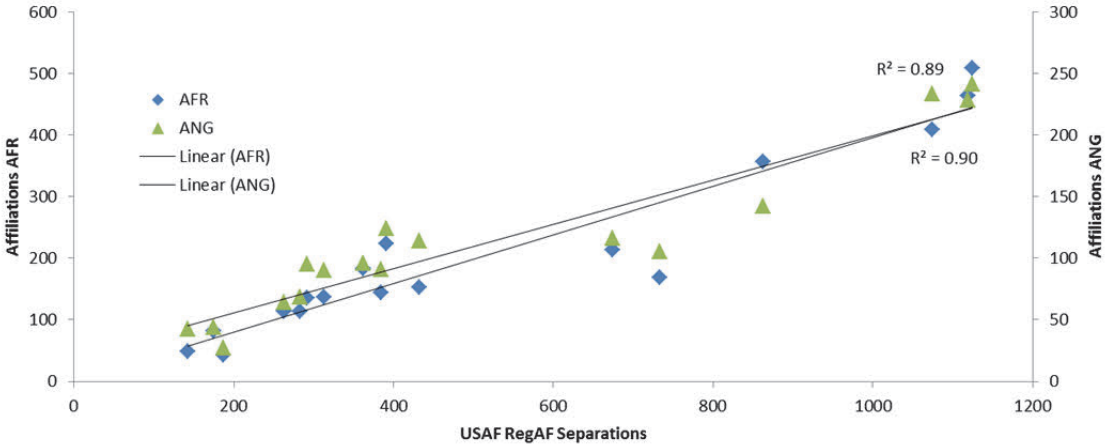
Figure 4.15. Scatter Plot of ANG and AFR Total Losses vs Major Airline Hiring[81]



SOURCE: (USAF/A1 and Bigelow 2014)

Another aspect of the increased separations from the RegAF because of major airline hiring is that the Guard and Reserves will see an increase in applicants for affiliation. The following chart demonstrates the relationship between USAF RegAF separations and ANG/AFR affiliations the following year.

Figure 4.16. Immediate ANG/AFR Affiliations vs USAF Separations[82]



SOURCE: (USAF/A1 and Bigelow 2014)

Using these data and the total loss rates for the RegAF, Guard, and Reserve, the numbers of applicants for affiliation will be slightly greater than the ANG losses and much greater than the AFR losses due to major airline hiring.

---

[81] Controls for force shaping years as is done later in the analysis.

[82] Pilots who were in the RegAF one year, and then in the Guard or Reserves the following year. This does not capture the total number of affiliations to the Guard or Reserve, since some pilots may wait more than one year before affiliating.

The total losses are only part of the picture since not every pilot who leaves the military desires a career with the major airlines. To approximate the supply of pilots entering the pipeline from the population of active duty pilots who leave the military, the previously discussed airline affiliation percentages are applied to the subsets of military pilots who separate and pilots who retire. The forecast subsets of military pilots who separate and retire for a given year are determined using the regressions found in Appendix E. As shown in Table 4.3, the ratios of reasons for pilot losses also changes depending on major airline hiring (MAH). When MAH is greater than 3000 pilots/year, the raw numbers of separations and the respective portion of the entire loss population rise (and thus a higher percentage of potential airline supply).

Table 4.3. Total USAF Losses 1996-2014: Average vs MAH[83]

Total USAF Pilot Losses	MAH < 3000 pilots/year		MAH > 3000 pilots/year	
Reason For leaving pilot population	Average #	%	Average #	%
Separations	305	35%	971	62%
Retirements	352	40%	384	25%
Promotion to O-6	161	18%	165	11%
Grounded and Other Losses	63	7%	44	3%
Total	881		1564	

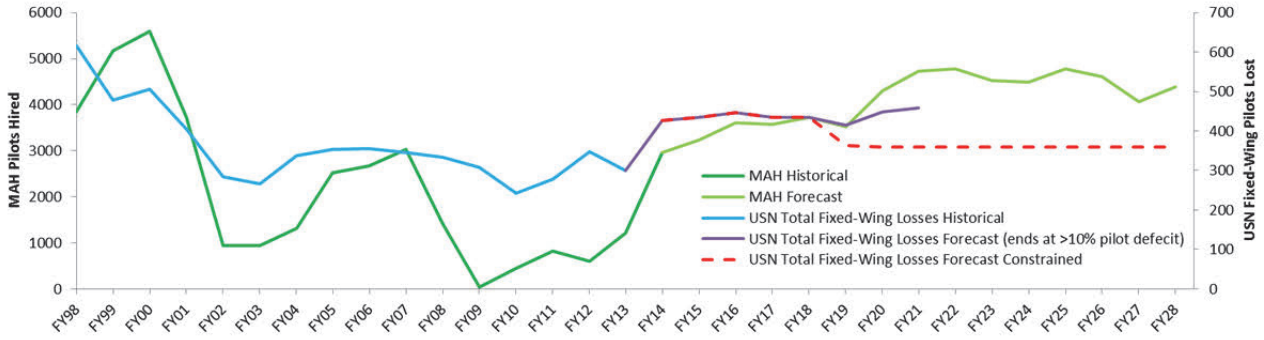
SOURCE: (AFPC/DSYA 1997-2013)

Similar modeling was accomplished for the USN, including the assumed policy implementation in FY19 to limit major airline hiring induced pilot departures from the service. Since major financial incentives, such as the ACP or "bonus," are Department of Defense level programs, this study assumes the major USAF and USN programs are implemented in the same year. The issue for the USN is that by FY19, this study predicts the fixed-wing pilot inventory will have already dropped to 325 pilots below an assumed 4000[84] fixed-wing pilot requirement. To correct this deficit, the USN will need to increase pilot accessions. The following figure compares historical USN fixed-wing pilot losses with the PF model prediction, both with and without the policy-induced corrections and constraints.

[83] Controls for force shaping years. The significant unexpected difference in "Groundings and Other Losses" for the years when MAH is < 3000 pilots/year is due to FY13, when AFPC reported 227 "Groundings and Other Losses", well about the normal average. If this year is factored out, this category drops to an average of 46 pilots/year, which is, as expected, in line with the years when MAH is >3000 pilots/year, which is 44 pilots/year.

[84] OPNAV N1, N13 confirmation Dec 14

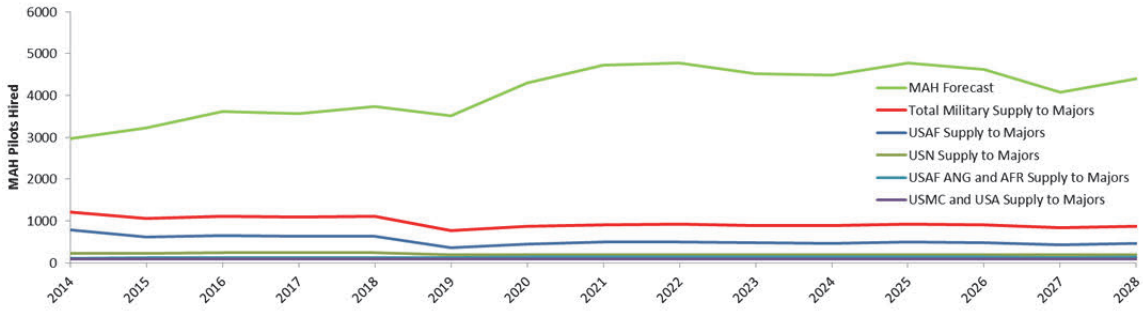
Figure 4.17. USN Pilot Losses – Historic vs Forecast[85]



SOURCE: PF Model

Both the different types of losses and the different major airline affiliation rates are applied to determine the forecast supply of military pilots for the major airlines. The figure below graphs the future forecasted supply of pilots entering the major airline node from the military. This model forecasts the total military supply to the pipeline at approximately 1100 pilots/year until FY19. As discussed earlier, the services will be forced to implement policy options to stem the numbers of separations to keep pilot inventories at acceptable levels. This assumed significant decrease in separations results in a decrease in the number of pilots flowing to the major airlines. The assumption on the constraint of flow at FY19 and beyond is applied, and thus the flow of military pilots to the major airlines drops to approximately 900 pilots/year in FY19 and beyond. The figure shows that the military provides a steady supply to the majors, but in times of elevated hiring, the additional pilots the majors require will have to come from the civilian ranks.

Figure 4.18. Military Fixed-Wing Pilot Supply to Majors



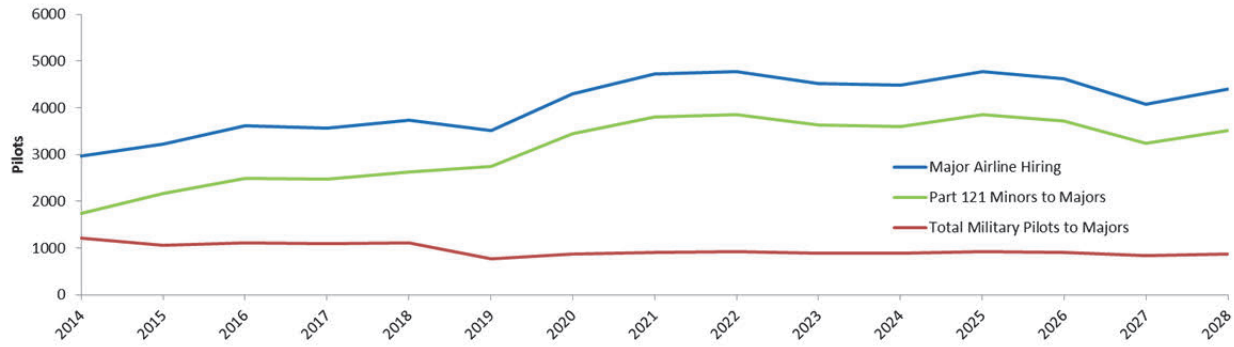
SOURCE: PF Model

[85] USN Total losses forecast stops at FY21 because the fixed-wing pilot deficit with no policy changes is expected to rise above 10 percent of total fixed-wing pilots. By FY 26, the prediction with no policy changes is a >20 percent total fixed-wing pilot deficit. This study assumes the USN would never allow the pilot deficit to extend beyond 10 percent of total fixed-wing pilots, thus it is an unrealistic scenario.

Minors

The minors flow to the majors is simply the difference between the demand at the majors minus the supply from the military. As shown above, the military is a constant and known source of pilots to the majors, but at increased levels of hiring, cannot come close to filling the demand. The majority of the supply to the majors comes from ATP pilots at the minors (regionals, or Parts 135/91(K)/125). Even in the late 1990s, when MAH averaged 4800 pilots/year, total separations (the category of military pilot losses most likely to flow to the airlines) of fixed-wing pilots from the USAF and the USN averaged only 1640 pilots/year. With the unrealistic assumption that 100 percent of separating military pilots went to the majors, the majority of new hires still came from the minors. The following figure depicts the required supply of pilots from the Part 121 minors to fill the majors demand. When MAH increases above 2200 pilots/year, more pilots are hired from the minors than from the military. As MAH increases above 3000 pilots/year, the minors supply over two-thirds of the pilots to the majors.

Figure 4.19. Supply Part 121 Minors to Majors

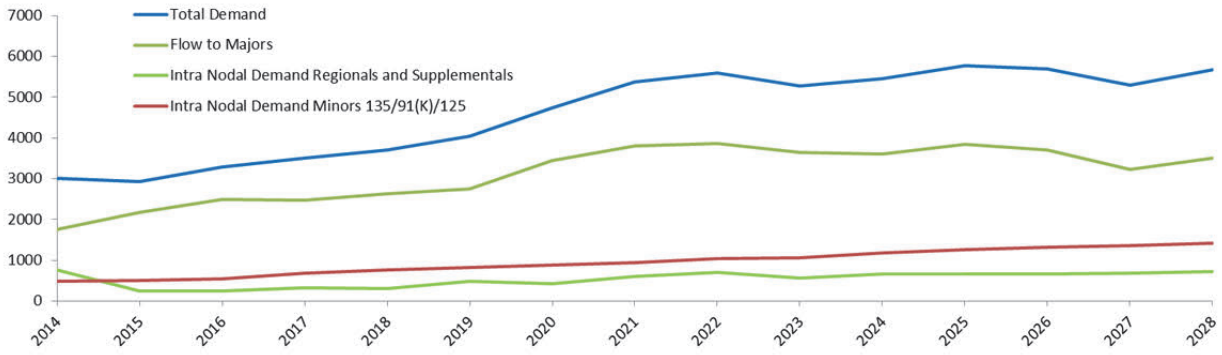


SOURCE: PF Model

Commercial and CFIs to the Minors

CFIs working at Part 141/61 training centers, Part 135/91(K)/125 SICs, Part 91, Part 137, and Corporate pilots typically fill the demand created at the minors. The total demand at the minors consists of the minors node outflow to the majors, plus the intranodal demand created by fleet expansion/contraction, retirements, and attrition. The following graph depicts the demand at the minors that is filled by the supply at the instructional and commercial nodes.

Figure 4.20. Minors Demand Filled by Instructional and Commercial Node Supply

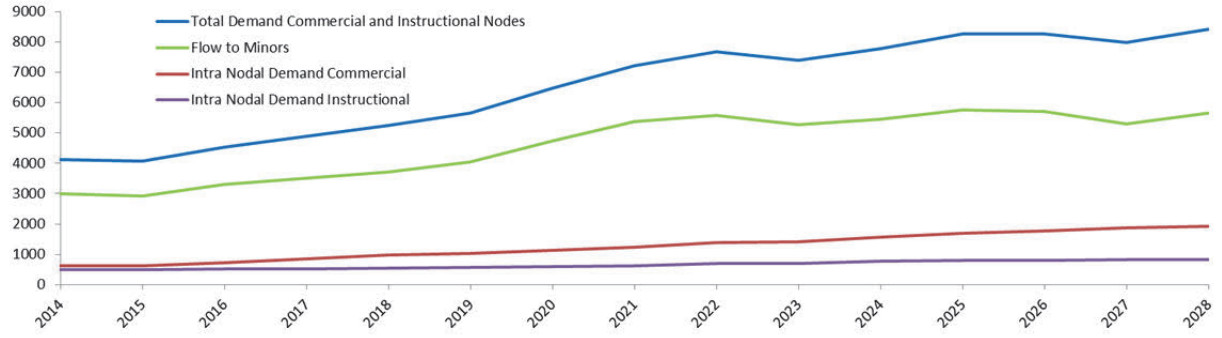


SOURCE: PF Model

New professional pilots entering the pipeline

The required future supply of professional pilots to the instructional and commercial nodes is calculated by adding the intranodal requirements of the instructional and commercial nodes, plus the outflow of these two nodes to the minors node. Since it takes approximately two years to build up enough time to qualify to progress to the minors node, the model employs an artificial progression limit to those new entering pilots.

Figure 4.21. Demand at Commercial and Instructional Nodes

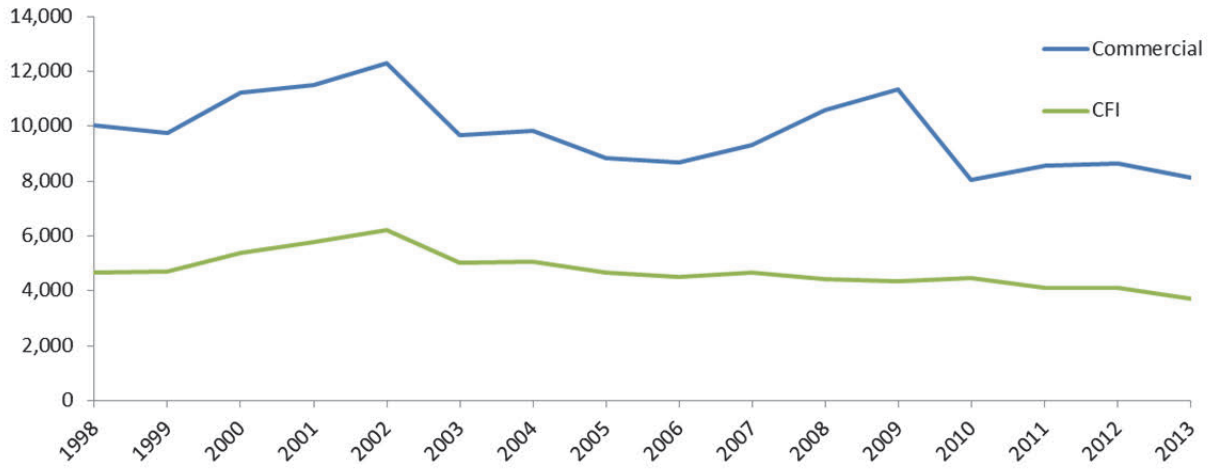


SOURCE: PF Model

Assuming the pilot pipeline in the United States is in equilibrium, 4115 new professional pilots in must be produced in 2014. This annual demand rises to over 6400 by 2020, and over 8200 by 2025.

As discussed earlier, the creation of CFIs is used a proxy for the supply of professional pilots into the pipeline.[86] New professional pilots entering the system must replace the supply provided to the minors by the instructor and commercial pilots. The following graphic depicts the new CFIs produced annually for the last 16 years.

Figure 4.22. FAA Original Licenses Issued



SOURCE: PF Model

The average of new CFIs/year produced over the last ten years is 4406 CFIs/year. The maximum number of CFIs produced in the last 15 years was 6221 in 2002. New production of both CFIs and commercial pilots has been trending down over the last 15 years. This should be expected, though, since MAH averaged only 1409 pilots/year over the past ten years. Even when the minors, commercial, and instructional nodes are included, many more pilots were produced than there were jobs for those pilots to fill. The outlook on MAH differs significantly from the recent past, so the question remains whether the pipeline will produce enough new pilots to fill the demand.

This model borrows from the work done in the 2013 UND study that developed two equations to predict future production of CFIs. The first is solely based on MAH.

$Y = .42X + 3789.87$[87]

[86] New CFIs were used instead of new commercial certificates. In 2012, approximately 45 percent of commercial certificates were issued to non-US citizens. CFI issuance did not suffer from the confounding issue of non-US citizens. Between 2004 and 2012, only approximately 10.68 percent of new CFI certificates were issued to non-US citizens. Higgins, J., et al. (2013). An Investigation of the United States Airline Pilot Labor Supply. Grand Forks, ND, University of North Dakota, University of Nebraska Omaha, Embry-Riddle Aeronautical University, Southern Illinois University, LeTourneau University, Middle Tennessee State University**:** 35.

[87] adj. R2 = .60, $F(1, 17) = 25.60$, $p < .001$

Where:

Y = Future Certified Flight Instructors

X = Number of pilots hired at major airlines;

The second is based on MAH and the change in cost of flight training.

$Y = .31X - 84.60Z - 14XZ + 4593.78$[88]

Where:

Y = Future Certified Flight Instructors over the next 3 years (distributed 5 percent in year +1, 25 percent in year +2, and 70 percent in year +3);

X = Number of pilots hired at major airlines;

Z = Percent change in cost of flight training (CFT) for obtaining Private Pilot certification (adjusted for inflation).

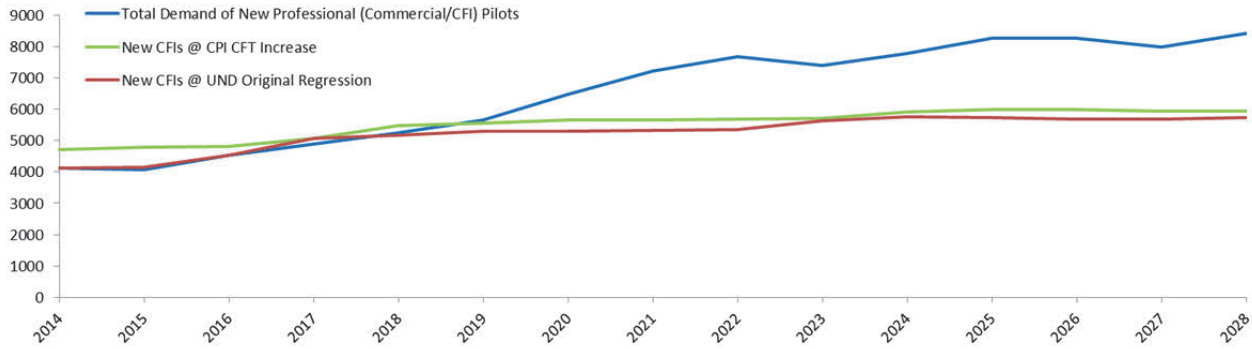
The baseline CFT used by the UND prediction was a 4.5 percent CFT above CPI increase in 2014, linearly rising each year to a 7.6 annual increase above CPI in 2028. In its 2014 study, the GAO reviewed the UND study.

> To predict future excess cost growth (the increase in the cost of pilot training over and above the general economy-wide level of inflation), the study extrapolated the growth of inflation in the cost of flight training over the past several years to the next 20 years. While using historic trends to predict future changes is part of forecasting, in some cases, it can lead to results that may be unlikely. In this case, this method resulted in forecasted year-over-year changes in the cost of flight school of almost 8 percent above its historic mean by the year 2030, which is well above historic averages over the past 20 years (GAO 2014).

This study agrees with the GAO assessment and assumes CFT follows increases in CPI. There may be cases where CFT actually rises slower than CPI, especially because of decreases in the cost of aviation fuel, which is a major contributor to the cost of flying aircraft. Using these equations, the following graph compares the expected new CFI production.

[88] $R^2 = .774$, $F(3, 15) = 21.55$, $p < .001$.

Figure 4.23. Forecast of Future Original CFI Licenses Issued[89]



SOURCE: PF Model

This data assume 86 percent of pilots who get their CFI desire a career as a professional pilot,[90] and adjusts to account for the professional pilots at the minors node who do not have a CFI certification.[91] The blue line represents the total number of new professional pilots required to enter into the civilian arm of the pipeline. The requirement (demand) is approximately 4000 in 2014, rising above 5000 in 2018, above 7000 by 2021, and above 8000 by 2025. This requirement is unprecedented in the U.S. system. The maximum number of CFIs produced in the last 15 years was 6221 in 2002. The two other lines represent the forecast for professional pilots entering the system given current conditions. If CFT increases match inflation, the demand does not outstrip the supply until after 2019, creating a shortage at the commercial node at that point, and a shortage at the minors node after 2021.

Both scenarios assume the pipeline is currently in equilibrium. As noted in the GAO and MITRE studies, there are thousands more current or formerly qualified pilots than there are available positions for employment in the pipeline. As of 1 October 2014, there are 147,502 active ATPs and 103,835 active commercial certified pilots who are in the United States. (FAA 2014) Of those totals, 15,766 of those ATP-certified pilots and 20,203 of those commercial-certified pilots are over 65 and not eligible for Part 121 employment. This model estimates there are 99,152 ATP and 40,318 commercial or instructional paid pilot positions in the United States. Assuming the FAA tracking is generally complete, there are 42,000 ATP certified pilots and

[89] This Cost of Flying (CFT) increase is an annual increase in cost adjusted for inflation using data collected on private pilot license costs.

[90] The Pilot Labor Supply and the role of Universities in Flight Training study noted that only 53 percent of their 2011 student hires went to the minors. Since this study looks at the entire pilot pipeline, it used the percent of pilots who were hired by a company in the instruction, commercial, or minors nodes, which is 86 percent in the aforementioned study.

[91] Per the 2012 Pilot Source study, 87 percent of the pilots surveyed in the minors node had a CFI certification at some point in their career. Thus 13 percent are not accounted for in the original equation. It is assumed the missing approximately 13 percent react similarly to CFT and major airline hiring.

44,000 commercial certified pilots who are not currently employed as professional pilots in the United States. Whether any of these pilots are still interested in the airline career is unknown. Also unknown is the percentage of these pilots who meet the minimum employment qualifications for operators at the commercial, minor, or major nodes. Obviously, this large number of potentially hirable pilots calls into question the assumption that the pipeline is in equilibrium.

If the pipeline is not in equilibrium, then determining the supply of ATPs for the minors requires a different approach. The issuance of new ATP certificates between 1994 and 2011 showed a significant relationship to MAH,[92] β=.82, $t(16) = 7.22$, $p < .001$. The regression did not improve by adding either CPI or changes in price of fuel.[93]

Figure 4.24. New ATP Certificates Compared to Major Airline Hiring

SOURCE: PF Model [94]

There is a significant increase in number of ATP certificates issued during 2012 and 2013 due to the new exogenous "1500-hour rule," thus these years were not included in the regression. Had they been included, it would overestimate the number of ATPs produced given any level of MAH. Assuming the pipeline is not in equilibrium, and there are thousands of commercial certified pilots who would get their ATP certificate if there were an employment opportunity,

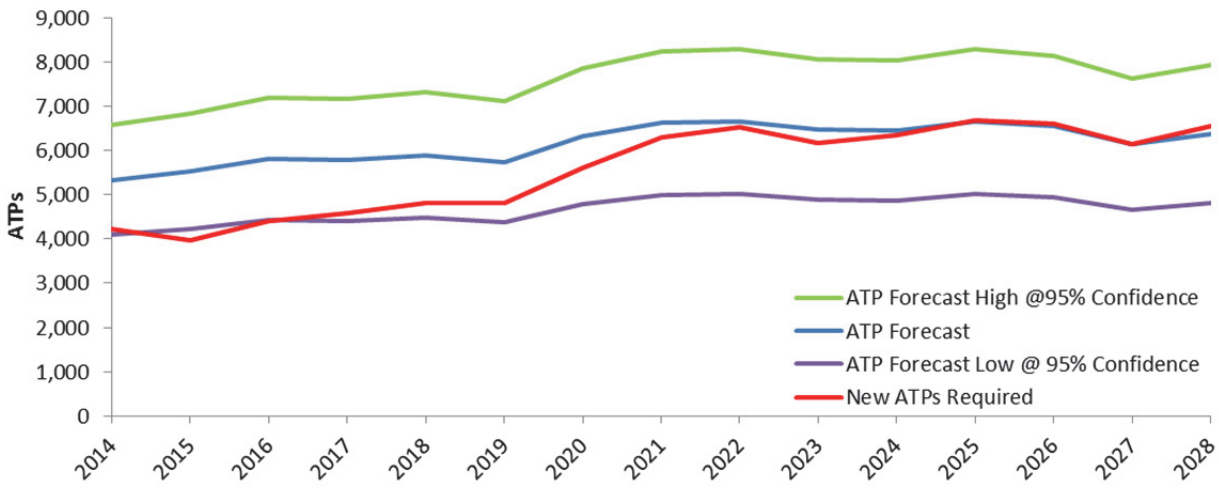
[92] Regression results of new ATP Certificates regressed on major airline hiring are included in Appendix E

[93] Both variables were not significant. Price of fuel is a main driver for flight training cost fluctuations. Many flight schools in fact add a fuel surcharge to account for these fluctuations. https://atpflightschool.com/international/fuel-surcharge.html

[94] http://www.faa.gov/data_research/aviation_data_statistics/civil_airmen_statistics/

then the following is the predicted number of new ATP pilots[95] based on historical trends. The graphic includes the high and low estimates at a 95 percent confidence level.

Figure 4.25. New ATP Certificates Forecast Compared to Major Airline Hiring



SOURCE: PF Model, [96]

Based on historical trends 1994-2011, even at the low error bound, there will be enough ATP certified pilots to fulfill the demand at the majors and minors for the next ten years. At the baseline forecast, there will be enough ATPs to fill the majors and minors demand until 2028. From 1990-2013, an average of 6009 ATP certificates were issued each year, 10560 commercial certificates issued each year, and 5058 CFI certificates issued each year. Major airline hiring averaged only 2250 pilots/year during the same timeframe. The sheer numbers of active commercial and ATP certificated pilots is tens of thousands more than the pipeline currently requires. The GAO, Audries, and MITRE studies all mention this apparent excess supply as the reason they predict no pilot shortage. This analysis provides further specification than the previous studies on this aspect, and indicates there is an excess supply of pilots, for at least the near term, who would fly professionally if the wages were sufficient.

---

[95] US Citizens. Based on FAA data between 2004 and 2012, 10.68 percent of the total ATP certificates were removed to account for foreign citizen ATP certificates.

[96] http://www.faa.gov/data_research/aviation_data_statistics/civil_airmen_statistics/

5. Supply/Demand Interaction and Near-Term Expectations

Building on the findings in the demand and supply chapters, this chapter applies those findings to discuss the effect of recent legislation, and the effects of the demand and supply for the majors, minors, commercial, and instructional nodes and the military.

Effect of Public Law 111-216, the Airline Safety and FAA Extension Act of 2010

Pilot certification and qualification requirements for air carrier operations ("1500-hour rule")

This rule introduced two main additional requirements for obtaining an ATP certificate. First, by requiring all Part 121 SICs to have at least an R-ATP, the minimum flight hour requirement for employment at these operators effectively increased from approximately 250 hours[97] to 1500 hours. On the surface, the new minimum hour increase seems like a drastic increase, but this jump in minimum required hours is not as large as it would initially seem. Most of the larger regionals already had a hiring minimum of between 800 and 1000 hours[98] in the mid-2000s, long before this new rule took effect. These are not the average number of hours new-hires needed to be competitive for employment, which was even higher. These are the historic minimum number of hours required to put in an application for employment. The process of gaining experience at the instructional and commercial nodes until acquiring enough flight time to be competitive for hiring at the minors is not new. Table 5.1 shows some historic snapshots of minimum flight hours required by various airlines at the minors node.

Table 5.1. Historic Regional flight hour Requirements

Airline (Former Name)	Airline (Current Name)	Current Rank in Regional Size	Hiring Minimums Flight Hours	Year
ASA	ExpressJet	1	800	2007
SkyWest	SkyWest	2	1000	2007
American Eagle	Envoy Air	3	1000	2006
Republic	Republic	5	800	2008

SOURCE: http://web.archive.org/web/20070112071722/http://www.flyasa.com/careers/pilot.php
http://web.archive.org/web/20070303075145/http://www.skywest.com/careers/pilot/requirements.php

[97] Approximate hours required to obtain a commercial certificate

[98] 1000 hours is also the required minimum time for a graduate from a 4-year university with a Part 141 flight program to qualify for an R-ATP.

http://web.archive.org/web/20060208095851/http://www.airlineapps.com/Intro/Eagle/default.asp
http://web.archive.org/web/20080405043811/http://www.rjet.com/emp-pilotcareerguide.html

This new rule will have an effect, but not nearly as severe as some have stated. Using previous hiring minimums, this rule has created an increased experience requirement between 0 and 200 more hours for graduates from Part 141 flight schools associated with four-year universities, 250-450 more hours for graduates of Part 141 flight schools associated with two-year colleges, and 500-700 more flight hours for all others. This rule had no effect on previous military pilots since all but a very few will have well over 750 hours by the time they are eligible for separation and subsequent employment with the majors. In addition, many of the pilots at the commercial node are required to have at least 1200 hours to fly in instrument meteorological conditions (IMC)[99], or more simply put, "bad weather". Thus, many of those pilots at the commercial node already were required to have flight hour minimums close to or above the new 1500-hour rule requirements.

This rule will, however, make Part 141 training associated with an aviation program at a college or university much more desirable. A graduate of a four-year university aviation program with an associated Part 141 flight training program receives a 500-hour credit for this training. A graduate of a two-year program receives a 250-hour credit. For a pilot who is self-funding the flying required to accumulate hours, this equates to an approximate $75,000[100] difference between pilots trained by a Part 61 school compared with a pilot who was trained by a Part 141 school associated with a four-year university. If a pilot is employed as a full-time professional pilot, this difference will equate to approximately an extra year of hour-building lower-wage employment before becoming eligible for an ATP certificate. Additionally, this training route opens up numerous low-interest subsidized federal grant and loan programs to help fund the education and training. Thus, pilots interested in a professional flying career have a significant incentive to attend one of these programs instead of taking a different training route.

The second requirement of this new rule is the requirement to complete the ATP Certification Training Program before obtaining an ATP or R-ATP. Part 121 air carriers (airlines), Part 135 operators (charter), Part 142 training centers (ground/simulator), or Part 141 pilot schools can give this training once authorized by the FAA. Level C FSTDs are expensive,[101] and are typically only owned by Part 61 flight schools or Part 142 training centers that specialize in large turbine training. One issue is that Part 61 flight schools, which historically have produced the

[99] IMC conditions are defined based on visibility, cloud heights, and sometimes separation from clouds depending on the type of airspace the aircraft is flying within.

[100] $150/flight hour for just a single-engine Cessna 172 equates to $75000 for the 500-hour credit. Example cost pulled 01 September 2014 at http://dfwflighttraining.com/the-fleet/

[101] AOPA estimates $8M for a new Level C FFS. http://www.aopa.org/-/media/Files/AOPA/Home/Supporting%20General%20Aviation/Advocacy/Regulatory%20&%20Certification%20Policy/FAAPilotCertificationandQualificationRequirementsforAirCarrierOperations.pdf

majority of ATPs,[102] are not allowed to give this training under the new rule. Similar to the first requirement of this rule, Part 141 flight schools benefit from this addition since only Part 141 flight schools or part 142 training centers are authorized to conduct this training outside of Part 121 or Part 135 operators.

Minimal effect on the pipeline

This study assesses that there will not be a major long-term effect as a result of this rule's implementation, and it will only minimally affect flow capacity of the pipeline. There is enough capacity at the commercial and instructional nodes to absorb the new pilots flowing into the pipeline as they build experience and flight time[103]. The main short-term effect will be a decrease in overall professional pilot flow. This flow decrease should only last two years as the pipeline re-balances to incorporate the new minimum requirements. Those pilots already in the Part 61 portion of the pipeline will take two years longer until they are eligible to enter the minors. Those pilots already attending Part 141 flight schools associated with a two-year college will take one year longer until they are eligible to enter the minors. For those pilots already attending Part 141 flight schools associated with a four-year college, there will essentially be no effect since the minimum requirement for application to large regional carriers was already 800-1000 hours. The long-term impact will be a flow shift away from Part 61 flight schools toward Part 141 flight schools associated with a two-year college or four-year university. This shift will decrease the added flight hour requirements impact over time, thus decreasing the overall impact of the new rule.

Significant impact from flightcrew member duty and rest requirements (FT/DT Rule)

This study assesses that the FT/DT rule will have a significant near-term influence on the minors and majors nodes. The PF model predicts an increased requirement of 755 pilots for the majors and 930 pilots for the minors node. The initial effect creating a requirement for more pilots will be largely complete by the end of 2014, and will not create a long-term effect on the pipeline. The long-term effect of higher labor costs for the airlines, though, will continue. The minors, with their smaller workforce and tighter profit margins, will feel the effect more than the majors will. Those operations that optimize pilot schedules within the guidelines of these new rules will experience less effect.

[102] http://www.kitdarby.com/page31.html

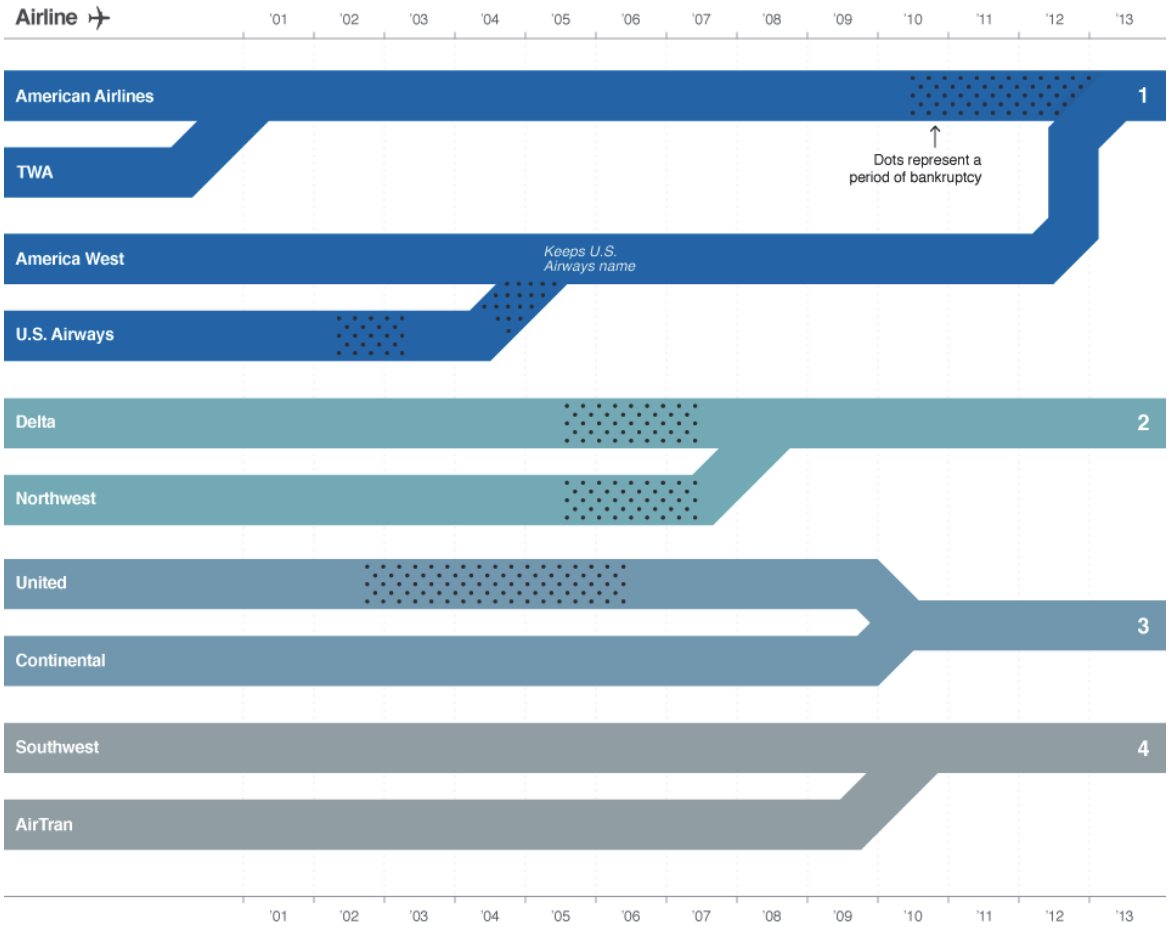
[103] The impact on the commercial and instructional nodes is discussed below.

Nodal Conclusions

Majors (Part 121 Network, National, Large Cargo)

The last decade was turbulent for the majors. The industry endured: 1) post 9/11 contraction of air travel; 2) a large number of bankruptcies, consolidations, and mergers; and 3) a major recession. Thus, a number of airlines disappeared, typically as a result of merging with another airline. Others went into bankruptcy. Figure 5.1 illustrates the effect.

Figure 5.1. Major Airlines Mergers and Bankruptcies



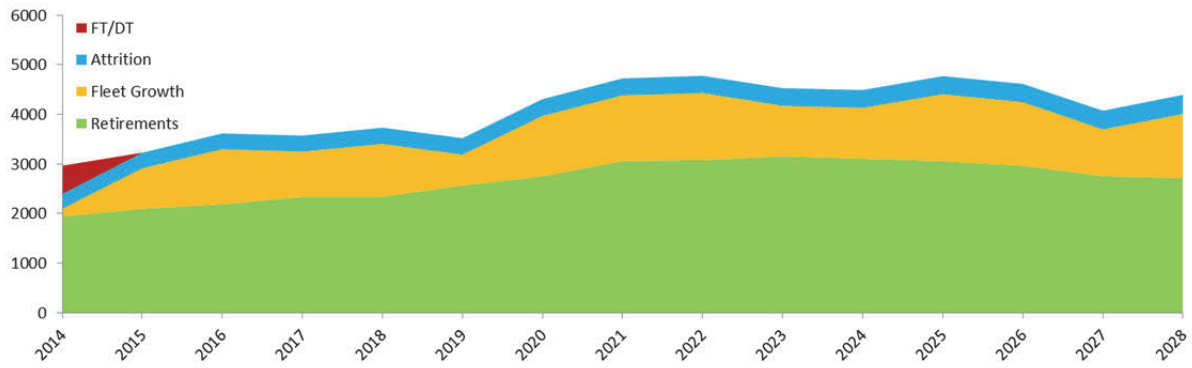
SOURCE: http://i2.cdn.turner.com/money/infographic/news/companies/airline-merger/020113-airlines-v3b.png

The majors, as a node, are financially healthy and are forecast to stay that way, at least for the near future. The major passenger airlines are experiencing record profits[104] and, barring any exogenous shocks, are forecast to continue steady growth.(FAA 2014)

Demand

This model forecasts hiring to increase above 3000 pilots/year in the near-term, and over 4000 pilots/year by 2020. Hiring will be driven mainly by retirements, but also due to steady expansion.

Figure 5.2. Major Node Demand Drivers



SOURCE: PF Model

Barring any exogenous shocks, this hiring increase will continue for at least the next 15 years. The duration of this hiring increase is unprecedented in the airline industry.

Supply

No foreseeable shortage. The majors will continue to see a steady stream of pilots from the military. The majority of future hires, though, will come from the civilian side of the pipeline. Though the minors will become strained over the next ten years as they contract and realign, this will not significantly affect the flow of pilots to the majors. As a result of the wages and benefits offered at the majors, this node will continue to see significant numbers of high-quality applicants for the available positions. The majors will therefore be able to choose the most qualified candidates.

Pay

Current pay tables have recovered to and have surpassed inflation-adjusted pre-9/11 levels[105]; with periodic pay raises above expected inflation rates scheduled in current contracts.[106] Future

[104] http://www.usatoday.com/story/money/business/2014/07/24/us-airlines-earnings-jetblue-united-southwest-american/13060163/

contract negotiations may include more pay raises based on industry profits above inflation. In fact, in recent contract negotiations, American Airlines pilots received a 26% pay raise to its pilots plus a 3 percent/year raise each of the next four years.[107] Delta pilots are scheduled to receive 15 percent of their 2014 earnings in profit-sharing, with similar payments in future years (Carey 2014). Delta and Southwest Airlines enter contract negotiations this year, and although this American pay raise was mostly "catch up" because theirs was the lowest at the time, they have now leapfrogged the others. All industry analysts expect the negotiations will go well for both Delta and SWA pilots to, as a minimum, catch up to the leader.

Minors (Part 121 Regionals, Small Charter, Small Cargo, Part 135 and 91(K) requiring ATP, Part 125)

A portion of this node, the regionals, has experienced significant volatility over the past four years, with three of the largest regionals having either shut down or declared bankruptcy within the last two years.[108] The regional industry is beginning to experience mergers, such as the 2012 merger of Atlantic Southeast Airlines (ASA) and ExpressJet, creating the largest current regional. The industry is going through a transition similar to the majors in the 2000s to cut costs and stay or become profitable. This volatility will continue through the near term.

Regionals pay is low and is one of the reasons given as a cause for the perceived shortage (GAO 2014); the average staring pay at the largest four regionals is $22,800.[109] Regionals compete with each other to gain capacity agreements[110] with the major airlines. Regionals win bids by offering the lowest price given an acceptable level of performance, safety, and customer service. To offer the lowest bid, they keep labor costs, including pilot salaries, low. Once in-place contracts come up for renegotiation, the pilot union, ALPA, attempts to negotiate for higher pay and benefits[111] while the regionals and the majors (if the majors own the given regional) negotiate to keep costs down. If a major does not agree with an offer, it can opt to

---

[105] Adjusted for inflation.

[106] United: 8.5 percent in Jan 2014, 3 percent in Jan 2015, 3 percent in Jan 2016; and 3 percent in Jan 2017; Delta: 3 percent in Jan 2015;

American: Variable percentage every year through 2018. Pay parity review with UA and DL in 2016.

[107] http://www.wsj.com/articles/american-airlines-us-airways-pilots-approve-joint-contract-1422634781

[108] 2012: Comair closed operations; 2013 Pinnacle declared bankruptcy, American Eagle declared bankruptcy.

[109] Salary data (does not include additional pay such as per diem, nor does it include any retirement benefits) for each of the top airlines built from airlinepilotcentral.com and audriesaircraftanalysis.com with the following assumptions:

Regionals – SkyWest, American Eagle/Envoy, ExpressJet, Republic, and Endeavor. CY14 $, 80hrs/month (pay based on hourly wage), No Interest, No scheduled pay raises factored in.

[110] Fly their aircraft and/or fly their feeder routes.

[111] Their argument is that if there is a pilot shortage, then wages should increase to attract more qualified applicants to alleviate the shortage.

move that contract to another regional willing to accept its offer. As the major replaces older 50-seat aircraft with newer 70- to 90-seat regional aircraft, it can also shift the new aircraft under agreements with another regional[112] to get the most cost-efficient contract. If the regional or major does not accept the contract offer, pilots have three choices: 1) accept the regional offer, which often includes pay concessions; 2) reject the offer, and stay at current pay rates with no increases; or 3) if the major is threatening to move its new aircraft to a new regional while retiring the aircraft the pilot is currently flying, then they may be required to look for employment at a different regional. Owing to the strict seniority system in the airlines, the pilot would start over at the bottom of the seniority list at the new regional. Average upgrade from FO to captain is at the seven-year point for the largest five regionals. Thus, as an example, if a pilot is past his/her first three years at the regional, there is typically no option to transition to the majors. A move to a new regional would add another 9 years until the pilot would be competitive for the majors.[113] Appendix D, offers an excellent example of these negotiations between Envoy (formerly American Eagle) and American Airlines.

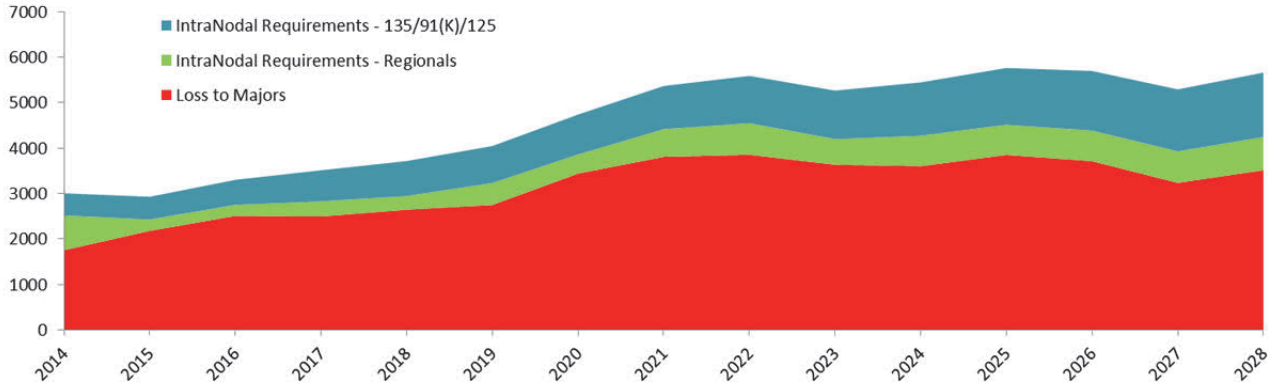
Demand

This model forecasts hiring to increase over the near term to above 3500 pilots/year by 2017, and over 5500 pilots/year by 2022. Hiring will be driven mainly by the need to replace losses of pilots to the majors. Trend will continue at least over the next 15 years; however, a constriction of the regional industry will dampen hiring increases, with the trend toward larger aircraft and mergers playing important factors in limiting regional growth. Part 135 and Part 91(K) relative growth will exceed that of the regionals. The following chart compares the drivers for this hiring requirement.

[112] For example, American Airlines operates contracts with Envoy, Piedmont, PSA Airlines, Compass, and Republic.

[113] Based on current flow-through agreements where the regional pilot is eligible after serving 2 years as a captain.

Figure 5.3. Minor Node Demand Drivers



SOURCE: PF Model

A significant increase in military pilots entering the majors will temper some of the pull from the minors in the near term as the U.S. Air Force reduces its inventory by over 1500 pilots by FY16 (USAF/A1 2014). If the pay and benefits offered by the majors outpaces the pay and benefit increases by the military, military pilot flow to the majors may further temper the demand from the minors.

Supply

Whether one assumes the pipeline is in equilibrium or that there is an excess supply of pilots who will work for the right wages, the data indicate the supply of qualified pilots applying for the minors will meet the demand through 2021. Assuming the pipeline is currently in equilibrium, the annual demand outstrips the supply at the minors after 2021[114], but is buffered by the excess production of ATPs in the preceding years[115]. In this scenario, the pilot supply deficit will not affect the majors from a personnel perspective until later in the decade, though the financial effects will be felt almost immediately since the regionals are the passenger feeder system for a significant portion of the majors passengers. This scenario will require significant policy changes before the shortage occurring to alleviate it. Assuming the pipeline is not in equilibrium (which this study does), the difference between new pilot production and demand for the minors after 2022 will be filled by the approximately 86,000 active commercial certified and ATP pilots not presently in the professional pilot pipeline.[116] In either case, the supply is sufficient for the demand in the near-term.

While there may be shortages of "most qualified" applicants, there will be enough "at least qualified" applicants for the open pilot positions. Those regionals offering the highest hiring

---

[114] Assuming a two-year timeframe for new commercial certified or CFI pilots to gain ATP minimums

[115] There will be approximately 8300 more ATPs produced than is required by the pipeline between 2014 and 2021.

[116] Reference Chapter 4, there are 42,000 active ATP certified pilots and 44,000 active commercial pilots who are not currently employed as professional pilots in the US.

bonuses, faster upgrades to captain, getting the newest aircraft,[117] and with multiple pathway programs[118] will see the largest pool of job applicants. Competition among minors for the "most qualified" candidates will increase, and regionals offering the lowest wages and those without pathway agreements will experience a trend of recently hired pilots with low seniority transitioning to other regionals offering better wages or flow-through agreements to the majors.

Excess supply of pilots means airlines can hire only the most capable pilots. When supply nears demand, airlines must hire some pilots they would otherwise not hire if the supply were greater. Whereas five years ago companies may not have hired pilots with issues such as previous DUIs, previously failed checkrides, previous misdemeanor drug convictions, previous driving record issues, or low educational grade point averages, they may overlook these disqualifying issues in the future if the only concern is to fill empty cockpits. From a safety perspective, this should concern the airlines, the FAA, and the flying public.

Regionals that offer the lowest pay, and the destinations they service, will see continuing struggles as the gap between the demand for pilots and the supply of pilots shrinks. Great Lakes Airlines is a good example of this trend. Great Lakes, a Part 121 minor, offers a starting pay of $16/hour, or approximately $15,360/year salary for first officers.[119] Great Lakes Airlines pilot numbers dropped from approximately 300 pilots in 2013 down to 78 on 1 April 2014 as they left for other regionals and the majors. This decrease resulted in Great Lakes cancelling service to over 14 of the 30 cities it serves. As its CEO put it, "We ran out of pilots."[120] Great Lakes is one of the minors that participate in the Department of Transportation (DOT) Essential Air Service (EAS) program. According to the Department of Transportation, "The EAS program was put into place to guarantee that small communities that were served by certificated air carriers before deregulation maintain a minimal level of scheduled air service."[121] The U.S. Government subsidizes flights to smaller airports that otherwise would not have service because of their low load factors and thus lack of profitability for the airlines. As of June 2014, the EAS program subsidizes air service at 117 U.S. cities at a cost of $226,515,545 annually.[122] The contracts for these cities are bid on a regular basis, and the lowest bidder who meets Part 121 requirements wins the bid. Operators such as Great Lakes are competitive for these contracts because their operating costs, including labor costs, are low. In this environment, when supply of pilots is

---

[117] If a major awards a large number of their new aircraft, such as the E175, to a regional, the perception is that there is long term stability at the regional. With the recent number of bankruptcies at the regionals, this is an important consideration for pilots in their employment decision.

[118] Agreement with a major to offer the pilot a guaranteed employment interview after a given number of years at the regional.

[119] http://www.airlinepilotcentral.com/airlines/regional/great_lakes_airlines

[120] http://www.cortezjournal.com/article/20140410/NEWS01/140419997/Airline-casts-doubt-on-service

[121] http://www.dot.gov/office-policy/aviation-policy/essential-air-service-reports

[122] http://www.dot.gov/sites/dot.gov/files/docs/Subsidized%20EAS%20report%20for%20non-Alaska%20communities-Jun%202014.pdf

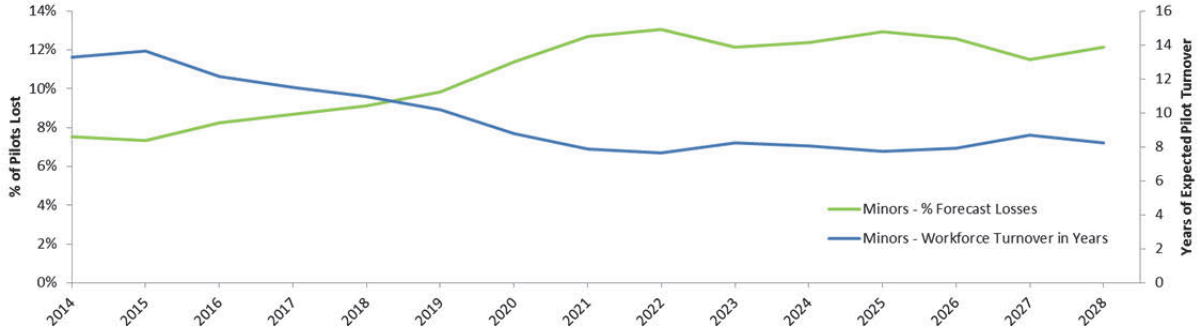
close to demand, operators who offer lower salaries have a tough time competing for the available pilots.

Many Part 135, Part 91(K), and Part 125 operations have a built-in supply of pilots. Operators, who require ATPs for their PICs, are allowed to fly commercial pilots as their SICs. If their PICs leave for the majors, they can upgrade their own SICs to ATP PICs, as long as they have built up enough flight time as a SIC. Great Lakes has adopted this tactic because it is currently in the process of physically removing seats from their B1900 aircraft, leaving only nine seats, which qualifies this part of their operation under Part 135. This action opens up a new supply of commercial pilots. It is interesting to note, relating to the "1500-hour rule discussed earlier," that even though they could hire 250-hour pilots for this new portion of their operation, their hiring minimums are still 600 hours for new commercial pilots.[123]

Turnover

The following graphic depicts the forecast losses at the minors as a percentage of their total number of pilots and the corresponding workforce turnover rate. These losses are only based on the number of pilots required for the pipeline. A company within the node may lose more or less than this average.

Figure 5.4. Minors Annual Loss and Pilot Turnover



SOURCE: PF Model

Not accounting for intranodal losses, companies at the minors can currently expect to keep their pilots an average of 13 years (as discussed in Chapter 6, the true average is shorter as a result of intranodal losses). That average time is expected to drop significantly over the next seven years, decreasing to an average of only eight years. This significantly higher turnover will

[123] https://greatlakesairlines-openhire.silkroad.com/epostings/index.cfm?fuseaction=app.jobinfo&id=23&jobid=28&company_id=16816&version=1&source=ONLINE&JobOwner=992273&level=levelid1&levelid1=36313&parent=Flight%20Operations&startflag=2

result in greater training costs because of the increased number of new-hires and captain-upgrades.

Pay

Until the regional industry goes through a process of consolidations and mergers, the pilots union may not have the leverage to successfully negotiate significantly higher wages and benefits for pilots at the regionals. As hiring levels increase, the competition for the "best qualified" candidates will increase. This competition may result in greater hiring incentives such as hiring bonuses and early year retention pay, but may not result in across-the-board pay increases.

Military

Separations

This study predicts USAF and fixed-wing USN pilots will separate at a higher rate than has been seen in the last ten years. Separations and total losses numbers will approach the levels seen in the late 1990s. Beginning in FY19, this study artificially constrains USAF total losses at approximately 1100/year[124] and USN at 360 total fixed-wing losses/year, assuming policy changes will be enacted to stem the flow of separating pilots.

Net effect on Pilot Supply

The Regular Air Force (RegAF) pilot requirements are planned to drop from 14,000+ pilots to approximately 12,500 in by FY16. This study predicts the USAF pilot inventory will concurrently decrease because of increased separations, but not as sharply as the planned requirements decrease. Thus, there will not be an overall pilot shortage in the USAF[125] through FY18. If no significant retention policy changes are implemented, there will be a shortage of RegAF pilots starting in FY19, and the RegAF pilot inventory will drop greater than 1000 pilots/10 percent below the RL by FY22.

This study predicts a "bathtub" in the FY04 and later year groups, similar to what was experienced for the year groups that came up on their "separate or take the bonus" in the late 1990s and early 2000s. This study expects these pilots to separate at higher rate than is currently predicted or planned.

With no policy changes, the U.S. Navy will experience a fixed-wing pilot shortage within the next two years as MAH exceeds 3000 pilots/year and separations correspondingly increase above planned levels. With no significant policy changes, this study predicts the USN inventory will

---

[124] Matching total pilot production to keep inventory = requirements.

[125] There is currently a shortage of fighter pilots in the USAF, and barring any major policy changes, this trend is predicted to continue.

fall below 3600 fixed-wing pilots by FY21, or >10 percent below the assumed 4000 fixed-wing pilot requirement.

In the early 2020s, assuming no significant policy changes, senior officer promotions will be affected by the shrinking pool of Lt Cols in the USAF and CDRs in the USN. USMC and USA pilot separations did not show a strong enough correlation to majors hiring, so this study cannot predict the same issues for these services.

Changes to forecast

Any major policy changes, such as increasing the ADSC/ADSO or significantly increasing the Aviation Continuation Pay (ACP), will decrease separation numbers. In addition, barring any financial incentive policy changes, shifting force structure to the Guard or Reserves will alleviate some of the pilot inventory shortfall, though such a shift has numerous secondary implications.

Commercial (Part 135, 91(K), 125)

Demand

Hiring will continue to increase over the near term. Hiring will be driven mainly by the need to replace losses of pilots to the minors. This trend will continue at least over the next 15 years.

Supply

The factors governing supply to the commercial node will be similar to those governing supply to the minors. Those companies offering the highest wages will maintain a healthy supply of applicants. Those Part 135, 91(K), and 125 operations that employ both commercial and ATP pilots will be shielded from many of the trickle-down effects of the major airline hiring increase. If the operation can offer an improved flow-through from a commercial SIC to an ATP PIC, it will escape the significant employee turnover commercial-only operations will experience. Those offering lower wages will transition from “most qualified” candidate to an “at least qualified” candidate as they experience losses to both the minors and to other commercial operations offering higher wages.

Whether one assumes the pipeline is in equilibrium or one assumes there is an excess supply of pilots who will work for the right wages, the data indicate the supply of qualified pilots applying for the minors will meet the demand through 2019. Assuming the pipeline is currently in equilibrium, annual demand outstrips the supply at the commercial node after 2019. Between 2020 and 2028, an approximately 15,000 pilot gap opens between predicted pilot production and pilot demand. This scenario will require significant policy changes before the shortage occurs to alleviate the potential shortage. Assuming the pipeline is not in equilibrium (which this study assumes), the difference between new pilot production and demand for the minors after 2019 will be filled by the over 86,000 active commercial certified pilots not presently in the

professional pilot pipeline[126]. In either case, the supply is sufficient for the demand in the near-term.

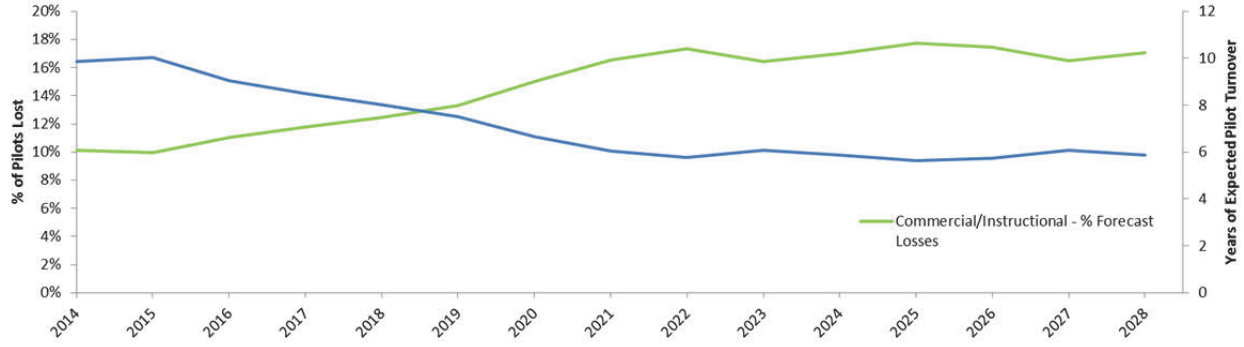
Though there will be enough "at least qualified" applicants for the open pilot positions, there may be shortages of "most qualified" applicants Those in the commercial node offering the highest hiring bonuses, the highest pay, and upgrades to captain in multi-engine and turbojet aircraft will see the largest pool of job applicants. Competition within commercial node for the "most qualified" candidates will increase, and commercial operators offering the lowest wages and those without multi-engine or turbojet aircraft[127] will experience a trend of recently hired pilots with low seniority transitioning to others in the commercial node offering better wages or captain opportunities.

The commercial node will experience the same potential safety issue as the minors when it comes to the hiring of quality pilots. Those commercial operators offering the lowest wages may need to decide between hiring pilots with previously disqualifying issues, accepting a pilot shortage, offering significant hiring and retention bonuses, or raising wages across the board. If airlines in this node decide to relax hiring standards, safety issues related to pilot error may arise.

Commercial and instructional node turnover

The following graphic depicts the forecast losses at the combined commercial and instructional nodes as a percentage of their total number of pilots and the corresponding workforce turnover rate. These losses are only based on the number of pilots required for the pipeline. A company within the node may lose more or less than this average.

Figure 5.5. Commercial and Instructional Node Annual Loss and Pilot Turnover



SOURCE: PF Model

[126] Reference Chapter 4, there are 42,000 active ATP certified pilots and 44,000 active commercial pilots who are not currently employed as professional pilots in the US.

[127] Many regional operators include a certain number of multi-engine and turbine hours in their hiring minimums.

Not accounting for intranodal losses, companies at the commercial or instructional nodes can currently expect to keep their pilots an average of ten years (as discussed in Chapter 6, the true average is shorter due to intranodal losses). That average time is expected to drop significantly over the next seven years, decreasing to an average of only six years. This significantly higher turnover will result in greater training costs because of the increased number of new-hires and captain-upgrades for those companies in the commercial node. While the instructional node expects high turnover from the instructor pilots, this shortened employee timeline for the commercial node will result in greater training costs owing to the increased number of new-hires and captain-upgrades.

Instructional (Part 141 and Part 61)

Demand

Hiring will continue to increase over the near term. It will be driven by both losses of instructors to commercial operations and the minors and by increased student loads. Part 141 training centers will benefit most from this growth the most since they offer reduced hour requirements to qualify for an ATP certificate. This growth trend will continue over at least the next 15 years. Part 61 flight schools will not share in this increased pilot training growth. Pilots who receive their training through Part 61 flight schools will be required to accumulate the entire 1500 hours before they will be qualified for an ATP certificate. If a pilot is not interested in a four-year degree, he or she can still receive a 250-hour credit by attending a community college with an associated Part 141 school and become eligible for an ATP certificate earlier than if they were trained at a Part 61 flight school. In addition, attending a two- or four-year institution with an associated Part 141 flight school opens up a significant number of grants and subsidized federal loan programs.

Supply

This study predicts Part 141 flight schools will experience significant growth in their student loads as the numbers of new pilots increase in reaction to hiring at the majors. Part 61 flight schools will not experience the same growth trend due to the reasons previously discussed. Part 61 flight schools will still a steady pool of new student applicants since recreational flying training will not be affected.

Unpredicted exogenous shocks that would change predictions

Numerous exogenous shocks would invalidate portions of the PF model predictions. A significant economic downturn, such as the recession experienced in the late 2000s, would result in decreased demand for air travel, thus affecting major airline growth. The spike of mandatory retirements would still drive hiring, but stagnant airline growth in the near-term would significantly temper that demand. A significant fuel price increase would not only cut profits at

all nodes, but it would also translate into an increase in CFT, thus decreasing the future supply of professional pilots. Another major terrorist attack associated with the airline industry would result in effects similar to an economic downturn, though the duration would be shorter.

6. Policy Implications

This chapter describes policy options available for the industry, government, and the military as they relate to the PF model results and near-term pipeline expectations discussed in the previous chapter.

Majors

Streamlined selection process (SSP) and flow-through agreements

SSP agreements between majors and regionals involve preferential interview and hiring process at the major once the pilot has been a captain at the regional for a given period of time. A flow-through takes this a step further and guarantees employment for an agreed-upon number or percentage of captains at the specific regional. These flow-through offers are extended after an initial comprehensive interview and remain valid contingent on pilot performance at the regional. SSPs and flow-through agreements with regionals provide significant benefits to the pilot, the regional, and the major if it is executed as intended.

Pilot

- It gives the pilot a known and stable flow from being hired at the regional as a first officer, to upgrade as a captain at the regional, to being hired as a first officer at the major

Regional

- It helps to promote a stable workforce since it provides an incentive for their first officer pilots to stay with the regional to keep their flow-through opportunity based on seniority.

Major

- Provides a known flow of experienced Part 121 captains into their workforce.
- Gives the major a greater opportunity to assess future employees, especially if their records at the SSP or flow-through regional are open for assessment by the major.
- For those majors that own their own regional, the workforce stability aids in forecasting the required number of future hires.

The greater the flow-through, the shorter duration pilots will spend at the regional, and consequently the more stable the flow of pilots since there is more stability at the regionals. Additionally, combining a regional bridge program with a majors SSP or flow-through program would provide a cradle-to-grave career path for new pilots and a known flow of future pilots. These two concepts are discussed in more detail in the regionals section.

One concern that must be addressed when setting up flow-through programs is the fact that the major airline is essentially is hiring an employee for 30 or more years before they know: 1) how the employee performed at the regional, and 2) if that employee will still be a good fit for

the specific company culture when they are ready to move from the regional to the major seven to nine years later[128]. Although the ability to offer a flow-through guarantee is a better recruiting tool for the regionals, an SSP agreement allows the major more flexibility to ensure the pilot, seven to nine years later, is still a good fit for their company. Adding strict continuing eligibility requirements, as was specified in the Endeavor-to-Delta flow-through program[129], can alleviate much of this concern.

There are also opportunities to establish bridge or guaranteed interview agreements with larger Part 135 operations requiring ATPs and Part 91(K) operations flying larger turbines.

Owned regional(s) and upgrade/flow-through times

Majors that own a stable regional benefit from a known supply of future pilots. Another benefit is that flow-through hires have flown under company-specific policies and procedures for the majority if not all of their Part 121 career. The major can also control the flow of pilots from regionals they own and thus keep the timeline of upgrade to captain and flow-through to their major operation at the minimum required for required Part 121 experience-building. The goal of most regional pilots is to flow to the majors, and if a pilot leaves one regional for another, he/she starts the progression timeline over again. If the major keeps the progression timeline at a minimum, they provide pilots incentives to stay at their regional, and then flow-through to the major.

Current upgrade time to captain for the largest five regionals is currently seven years.[130] This equates to a nine-year timeline for flow-through to the majors under current agreements.[131] Appendix G compares the difference between across-the-board pay increases at the regionals and earlier upgrades to captain and thus an earlier flow-through to the majors. By year 15 of a 40-year career, the career earnings of a pilot who upgrades to captain at the regionals a year earlier and thus flows-through a year earlier to the majors surpasses the pilot who flew for a regional with 25 percent higher than average pay. By year 14 of a 40-year career, the career earnings of a pilot who upgrades to captain at the regionals two years earlier and thus flows-through two years earlier to the majors surpasses the pilot who flew for a regional with 50 percent higher than average pay. Upgrade to the majors earlier far outweighs pay raises at the regionals; this policy provides a significant recruiting tool that can be used to attract the most qualified applicants.

This discussion only applies to network majors that count on feeder regionals for a portion of their passenger share. Majors, such as Southwest, employ a different business model and thus do not count on feeder regionals for their passenger base.

---

[128] Approximate time for the pilot to upgrade and then have two years' experience as a captain at the regional.

[129] http://www.endeavorair.com/documents/EtD_Program_Website.pdf

[130] http://www.airlinepilotcentral.com/airlines/major-national-lcc

[131] Flow-through after 2 years of service as a captain

Uniformed Services Employment and Reemployment Rights Act

The Uniformed Services Employment and Reemployment Rights Act (USERRA)

> is a federal law intended to ensure that persons who serve or have served in the Armed Forces, Reserves, National Guard or other uniformed services: (1) are not disadvantaged in their civilian careers because of their service; (2) are promptly reemployed in their civilian jobs upon their return from duty; and (3) are not discriminated against in employment based on past, present, or future military service.[132]

USERRA places a burden on airlines because, if they hire Guard or Reserve pilots, they are forced to hire more pilots than their requirement to cover for these pilots when they take military leave. This known "cost" of hiring a Guard or Reserve pilot is offset by the known quality of employee the airlines are hiring. The demand for military pilots, though, is not the same at all major airlines.

During interviews, many airline senior personnel managers expressed their frustrations in how USERRA is applied in practice.[133] The following is a list of their concerns with USERRA:

- Lack of a required period of notice to the airlines when Guard/Reserve members go on military leave, especially during summer months and holidays when airline pilot manning is critical
- "Blank check" for Guard/Reserve members. They can come and go at will for whatever duty they choose with no regard to employer needs
- No requirement for reasonableness, actual military need, or appropriateness of duty requiring military leave from Guard/Reserve members or units
- Requirement to provide some benefits even though Guard/Reserve members provide no service to the employer (e.g., retirement)
- No requirement for Department of Defense to monitor units or Guard/Reserve members for proper use of privileges
- No recourse for the airlines when Guard/Reserve members or units abuse privileges

While all airline senior personnel managers indicated abuses of the system were not prevalent, they did happen, and such abuses threatened the integrity of the program. The concern is that if there is a perception of abuse of the intent of the law, major airlines could shy away from holding military pilots in such high regard as employees. This not only affects the pipeline supply, but also affects the post-military employment opportunities for military pilots and potentially the high affiliation rates enjoyed by the Guard and Reserve[134] by pilots separating from active duty.

---

[132] http://www.esgr.mil/userra/what-is-userra.aspx

[133] Inputs are unattributed do to the sensitivity of the subject.

[134] Many Guard pilots also fly with the airlines. The attractiveness of this arrangement is the pilot can continue to serve their country and fly military jets while also enjoying the benefits of airline employment.

Minors

New-hire employee departures

As shown in Figure 5.4, the minors will average a 7.5 percent loss of pilots in 2014, equating to a 13.3-year workforce turnover. In 2022, the average loss for the minors reaches a maximum of 13 percent, equating to a 7.7-year workforce turnover.

Typically, losses at a specific company will be higher because the forecast does not account for pilots who leave one company to work for another within the same node. Based on the first eight months of 2014, ExpressJet was projected to lose approximately 16 percent of its pilot workforce in 2014. That rate is an example where the losses are well above the forecast. To disaggregate these losses further, 38 percent (197 of 522) of their losses were FOs within their first three years of employment.[135] If the loss of recently-hired FOs is removed, ExpressJet's losses were within 3 percent of the forecast.

Although 42 percent of ExpressJet's losses within the first eight months of 2014 were listed as being for "unknown" reasons, 14 percent of the "known" losses were to other companies in the minors node. This trend is not unique to ExpressJet. When a regional loses an FO to another regional during the first three years of employment, it incurs a training cost for the replacement pilot they would otherwise not incur if they kept that pilot though upgrade to captain. This added cost can be significant.

If a specific company is losing 13 percent of their pilot workforce annually to retirements, attrition, and the majors, and their losses rise another 38 percent as a result of loss of pilots to other regionals, they will reach an annual loss rate of 17.9 percent, with a workforce turnover of only 5.6 years. At some level, loss rates become financially unsustainable due to training costs and operational stability. Whereas regionals and other operators in the minors node cannot control their losses to the majors, they can control their losses to others within the minors node.

The counterbalance to this process, though, is that the greater the loss of captains, the quicker the upgrade to captain for the FOs, and thus a shorter timeline for a pilot to be competitive for employment at the majors. Thus, as losses rise due to flow-through to the majors, the incentive to stay with a company increases. This is especially true for pilots flying large multi-engine jets, experience valued at the majors.

When a major hires a pilot from a regional, they typically hire an experienced captain. In fact, the Endeavor to Delta flow-through minimum requirement is at least two years' experience as a captain before pilots will be considered for an interview.[136] Under current loss-rates at the regionals, this means the first time a regional pilot is employable for the majors under this flow-

[135] In 2012, 27 percent (52 of 195) of ExpressJet's annual losses were FOs within their first three years of employment.

[136] http://www.endeavorair.com/documents/EtD_Program_Website.pdf

through agreement is at the 9-year point of employment.[137] When a pilot leaves one company to another within the node, it is with the full knowledge they will be starting at the bottom of the seniority rung again. Thus pilots who leave a regional within their first three years at the company typically leave for another regional where they expect quicker upgrade to captain, a better flow-through to the majors, a flow-through to a major they favor more, or better pay. As discussed earlier, if a pilot leaves one regional after his/her first year, but can upgrade to captain two years earlier and thus be competitive for a major a year earlier than at their original regional, he or she will make more money over a career. The same holds true for a pilot that leaves a regional after two years but can upgrade to captain three years earlier at the new regional, and so on. Every year delayed getting to a major means one less year of the highest pay (currently a weighted average of $247,327/year[138]) at the major airline.

SSP and flow-through agreements

As discussed earlier, these programs have shown to be effective recruitment and retention programs at the regionals, as long as the volume of hiring at the majors keeps the regional-to-major timeline reasonably short. The shorter the flow-through timeline, the more effective these programs become. Those regionals without significant agreements with the majors may experience more difficulty recruiting the "best qualified" applicants over the long-term.

Signing bonus

As mentioned earlier, the debt for flight training can be significant. Signing bonuses are an often-used recruiting tool, even by the U.S. military (albeit not for pilots). Offering a signing bonus can alleviate some of the financial stress for the new-hire pilots.

Retention Incentives

Losses of recently hired pilots create a cost burden associated with training new replacement pilots. If the minors can retain their newly hired pilots through upgrade to captain, this cost burden is eliminated. In most cases, keeping the pilot employed for over three years guarantees that pilot will stay with the airline through at least year seven. For example, only nine of the 195 pilot losses for ExpressJet in 2012 were in the 4-6 years of employment groups. Only four of the 522 pilot losses in the first 8 months of 2014 were in the 4-6 years of employment groups. A retention bonus or a provident fund is effective retention tools.

---

[137] All conclusions are based on current in-place salaries. Average upgrade to captain for the largest five regionals (SkyWest, American Eagle/Envoy, ExpressJet, and Republic) is at the 7-year point.

[138] Weighted average of United, Delta, American, FedEx, and Southwest.

Retention bonus

The U.S. military offers retention bonuses during specific years of a pilot's career to incentivize them from leaving. For the regional airlines, these critical years are the first three. Without having to increase wages for all pilots, a regional can use this bonus as not only a recruitment tool, but more importantly to incentivize these specific employee year-groups from going to another regional.

Provident fund

Similar to international airlines such as Emirates[139], regionals can offer a provident fund that stipulates the pilot be entitled to the full 100% of the value only after a given length of service. For example, the regional can contribute an amount equal to a given percentage of the pilots pay each year for the first four years that is paid out only after four years of service.

Industry-high payscales

The largest regionals all offer starting wages within a $5000 range, between $21,000 and $26,000.[140] The highest-paying regional, American Eagle/Envoy, just ended contract renegotiations with their pilots asking for wage concessions in return for receiving the newest E175 aircraft set to replace the aircraft they currently fly. The company asked for these concessions to keep costs competitive. When the negotiations failed, the American Airlines Group ended up reassigning the new aircraft to Compass and most likely Piedmont[141], and is giving what is remaining of their CRJ fleet to PSA[142], two of their other regional subsidiaries. There is a current trend at the larger regionals to cap pay in exchange for future job security. As long as there are other regionals whose pilots will agree to pay caps and can provide the same safe operation of the regional aircraft, pilot unions will have little negotiating power to achieve increased wages. Only when there are no viable alternatives for the majors to give their regional contracts to another provider will the unions have enough negotiating power to affect salaries. As discussed earlier, the regionals are entering a period of consolidation and mergers similar to the majors in the mid-2000s. If the number of large regionals decreases similar to when the majors consolidated from 10 to 4 airlines, then the ability to shift regional contracts will be limited, and there will be opportunity for the pilot union to affect wages. Until that point, significant wage increases across the board will not occur. There will, however, be a trend to offer increased signing bonuses and/or retention pay for new hires in an effort to recruit and keep

---

[139] http://www.emiratesgroupcareers.com/english/careers_overview/pilot_jobs/pilot_faq.aspx

[140] ibid

[141] http://aviationblog.dallasnews.com/tag/psa-airlines/

[142] http://aviationblog.dallasnews.com/2014/09/american-airlines-plans-to-transfer-planes-from-envoy-air-to-psa-airlines.html/

the "most qualified" candidates. Matching industry-high payscales will at least put a regional on an equal playing field for recruiting purposes.

Combined Part 121/135 operation (smaller planes or charter)

Similar to the actions Great Lakes was forced to take because of pilot losses, smaller regionals that fly very low load-factor routes as part of the EAS program may have the opportunity to make a portion of their operation Part 135. Operating costs will be lower by flying higher load factors on smaller aircraft. It will also allow airlines to hire commercial pilots, and create an intra-company flow-through from Part 135 to Part 121, followed by a flow-through to the majors. An added longevity incentive would be to offer an in-house ATP CTP in exchange for a given time contract. This option would provide employment stability not only for the pilot, but also for the regional.

Bridge agreements

Bridge agreements are typically offered by regional airlines and are guaranteed interviews or conditional employment offers for pilots in flight schools who do not yet qualify for the regionals. While some regionals have established bridge agreements with certain large flight schools,[143] these can be extended to almost every Part 141 flight school and many Part 61 flight schools. These bridge agreements could also be introduced to Part 135 operators in the commercial node, further expanding the potential supply of pilots.

Combining a flight school bridge agreement with a major airline flow-through agreement would establish a seamless career from flight school to the majors. This offer would not only enhance recruiting, it would also provide the pilot with a clear career path. This career certainty would increase the probability a new-hire pilot would stay with a single regional until employment at the majors. The pilot would receive a conditional employment offer while in flight school, and then still be required to pass the comprehensive initial interview for the flow-through program at the regional. This cradle-to-grave type of program would offer a known flow of pilots through the regional and to the associated major.

Part 135 and Part 91(K) bridge agreements with majors

Similar to agreements that majors currently have in place with regionals, Part 135 operations that require ATPs and Part 91(K)s that fly larger turbines can establish bridge agreements with the majors. These can work as recruiting tools for commercial pilots, offering them a known career path from commercial-rated FO, to an intra-company upgrade to ATP and a captain position, to an interview with a major after a specified period of time serving as a captain.

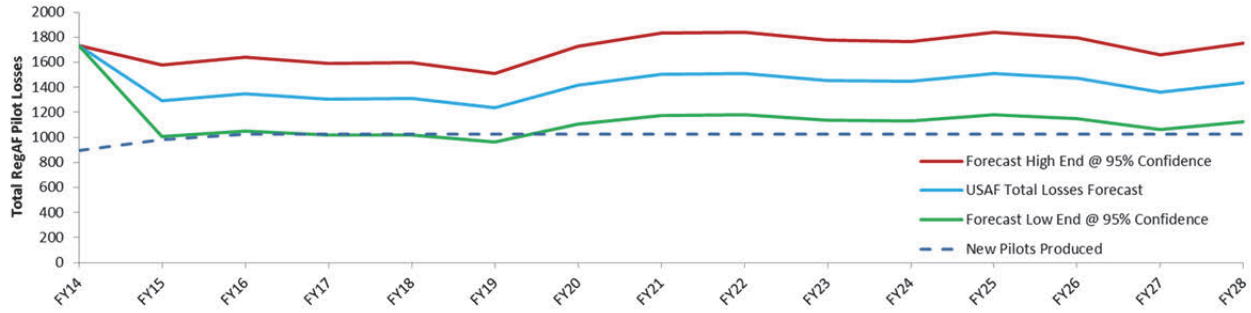
---

[143] http://news.erau.edu/top-news/embry-riddle-aeronautical-university-and-american-eagle-airlines-establish-pilot-hiring-program.html

Military

The number of forecast separations from the military due to major airline hiring is unsustainable within the next five years. The USAF has a built-in buffer because the service is in the process of dropping its pilot inventory by over 1000. The problem for the USN will be more immediate. One issue with the forecast is the possible margin of error. While the correlation of military separations to major airline hiring is very high, the relationship is inherently "noisy". Put another way, many exogenous and unmodeled variables affect these losses. Factors such as Air Force leadership, the frequency and length of deployments, and the number of extra duties have been ranked high as reasons why pilots decide to separate (Elliott, Kapur et al. 2004). Some of these variables, such as attitudes towards leadership and extra duties, are difficult to quantify and are not included in the model. These exogenous variables create enough error in the data to warrant caution in effecting immediate policy changes. The following graphic depicts the forecast bounds at differing levels of confidence, and the dotted line depicts the currently planned production rates.

Figure 6.1. AF Pilot Losses Forecast



SOURCE: PF Model

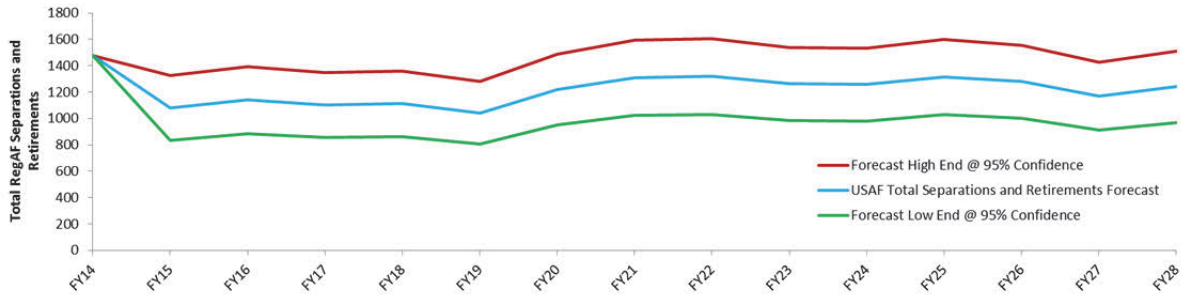
At a 95 percent confidence level, this model can only predict that after FY19, the USAF needs to increase pilot production slightly above 1100 pilots/year to keep inventory stable. At a 75 percent confidence level, the forecast losses indicate the USAF needs to also implement other policy options, such as raising the ACP or increasing the ADSC. It is just as probable the losses could be at the high end of the forecast as at the low end of the forecast, requiring drastic policy options implemented before FY19 to keep the inventory stable.

Total losses include not only separations and retirements, but also promotions to O-6, groundings, and other.[144] Promotions, groundings, and factors associated with "other" are not affected by major airline hiring. By only focusing on separations and retirements, the error band in the forecast decreases slightly, but only enough to state that at a 95 percent confidence level,

[144] Other category includes deaths and other losses that had insufficient numbers of data to broadly categorize.

the USAF must implement policy changes beyond just increasing production post-FY19 to keep inventory stable. Again, the number of separations and retirements are just as likely to be higher than forecast.

Figure 6.2. AF Pilot Separations and Retirements Forecast



SOURCE: PF Model

Using the baseline forecast, the number of separations will need to be decreased in the USAF by the following amounts shown in the table to keep the pilot inventories stable.

Table 6.1. Decrease in USAF Pilot Separations Required

	FY19	FY20	FY21	FY22	FY23	FY24	FY25	FY26	FY27	FY28
USAF Separations	45%	43%	42%	41%	42%	42%	41%	42%	43%	42%

SOURCE: PF Model

Fixed-wing pilot production

Increasing fixed-wing pilot production with available resources can offset minor increases in separations above what is acceptable to maintain inventory without having to gain authority from OSD to raise the ACP. Based on the forecast, the USAF would need to increase pilot production to the maximum possible with current pilot and aircraft inventories, to 1100/year by FY19. This study did not have access to reliable fixed-wing pilot production maximum numbers for the USN. The forecast does indicate the USN will need to increase fixed-wing pilot production by FY17 to keep pilot inventories within 10 percent of the requirement. This requirement is a more pressing one for the USN since this service does not have the same built-in pilot inventory buffer as the USAF.

ACP

Raising the amount offered by the ACP, or the "bonus" is one of the most direct means of providing pilots an incentive to stay until at least 20 years of service. The ACP maximum amount of $25K/year has not risen since FY00. To limit pilot separations by the percentages in

Table 6.1, the USAF would need to increase the ACP between 100 percent and 150 percent based on the previous RAND study *Modeling the Departure of Military Pilots from the Services.* To raise the ACP, the services will need to convince the Office of the Secretary of Defense and Congress of the need to increase the ACP authorization. An updated *Modeling the Departure of Military Pilots from the Services* study will better indicate the exact ACP increase required.

Under current authorizations, the services can extend the ACP offering to the previously-offered contract length of 25-years, with 50 percent up front. This is a more pressing option for the USN. The USN does not have the same buffer the USAF has generated by decreasing its inventory over the next two years, so the forecast effect will be felt much sooner by the USN.

Actual military pilot losses between FY14 and FY18 will give a clear indication if this study's forecast is correct. The USMC and USA should closely track separation numbers, and implement the ACP similar to the USAF and USN as warranted.

The military should be open to researching other ACP options such as giving the $25K/year bonus to O-1s starting immediately after pilot training for five years if they agree to a 15-year ADSC.

ACIP

ACIP has also not risen since FY99 when the maximum amount for aviators with over 14 years-of-service was raised to $840/month. If the ACP were adjusted for inflation, that pay would equal $1190/month in FY14[145]. The FY99 increase was an attempt to counter the significant military pilot losses in the late-1990s when major airline hiring rose significantly.

Active Compared with Guard/Reserves force structure

There is a significant relationship between pilot separations from the active-duty and subsequent pilot affiliations with the Guard and Reserves. For every 100 pilot separations from the active duty, there are approximately 40 Reserve and 18 Guard affiliations.(USAF/A1 and Bigelow 2014) This relationship provides an opportunity to keep experienced pilots in the military. Of the total pilots in the USAF, 66.3 percent are in the active-duty (RegAF), 17.5 percent are in the Air National Guard (ANG) and 16.2 percent are in the Air Force Reserves (AFR) (USAF/A1 and Bigelow 2014). Previous RAND studies have established the maximum sustainable force-mix of RegAF to ANG/AFR is approximately 50 percent/50 percent. (Robbert 2014), (Robbert 1999) In a period of increased RegAF separations, a force mix closer to 50 percent/50 percent would provide the opportunity to retain pilots who separate by providing available positions in the ANG and AFR. The numbers of separating RegAF pilots that affiliate are higher than the ANG/AFR losses during elevated periods of major airline hiring.[146] With the current force mix and at high levels of major airline hiring, there are more pilots who would

[145] http://www.bls.gov/data/inflation_calculator.htm

[146] See Appendix E for regression outputs.

normally affiliate than there are open slots in the ANG and AFR. A 50 percent/50 percent mix would bring this inequality into closer balance, though the relationship would still hold true with an equal mix of pilots in the RegAF and ANG/AFR. The added other aspect of this force structure change is that some of the pilot production slots normally used by the ANG could be transferred and used as RegAF pilot production slots using the same resources currently used.

ADSC

In FY00, the ADSC was raised from eight years to ten years to limit the separations of active-duty military pilots based on the experience of increased major airline hiring in the late 1990s. ADSC begins after graduation from pilot training. The concept was that pilots were more apt to stay until 20 years-of-service if they were closer to retirement. There is not enough data yet to reliably predict the results of this ADSC change.[147] Over the next few years, more data will provide reliable estimates on the effect of this policy change. If this ADSC change of two years made a significant difference, it opens the door to further increasing the ADSC to 12 years to limit military pilot separations in the face of the unprecedented forecasted duration of major airline hiring.

Other ADSC options could be examined. If force structure is transferred from RegAF to the Guard/Reserves, another option is to keep the basic ten-year ADSC, but add an option at eight years post-pilot training to separate and affiliate with the Guard/Reserves and agree to serve part-time for another six years. This option would only work if force structure were sufficient in the Guard and Reserves to absorb pilots who choose this option. For pilots who desire a career with the major airlines and are pre-disposed to separate at ADSC completion, this option would accomplish the following:

- Guarantees the military retains their experience four years longer
- Allows the pilot to begin their airline career two years earlier while still serving their country and flying military aircraft
- Still allows the pilot the opportunity to gain enough experience to be competitive for hiring at the major airlines (GAO 2014, HQDA 2014)

Commercial

Bridge agreement/guaranteed interview

Commercial operations that do not require ATPs can benefit from bridge agreements similar to what Part 141 and Part 61 flight schools have implemented with the regionals. This can aid as a recruiting tool as it does for the flight schools. Commercial operations that also require ATPs (thus straddling the commercial and minors node) already have the ability to offer upgrades to

[147] The first cohort of pilots, FY00, affected by this change entered their separation window in FY11 and FY12.

ATPs and captains as a recruitment tool. As discussed earlier in the minors section, faster upgrades, and thus faster transition to the majors, often trumps increased pay.

Signing bonus/student loan bonus

Similar to the minors, there are multiple financial incentive structures available to recruit the "best qualified" candidates for employment, and to retain these pilots for a given period of years. The same incentives are available for commercial operators. Unique to commercial operators is the fact that these candidates more recently completed their flight training and thus the financial burden of loans is more immediate. Structuring incentives to help with this burden can be used as a recruiting tool. For example, an initial signing bonus with an additional bonus after three years of employment can help both recruit and retain the "best qualified" candidates.

Instructional

Cost saving – CFT

The 2013 UND study determined a link between the cost of flight training and students who pursue a career in professional aviation. Given this relationship, flight schools can increase enrollment in their programs by finding ways to limit CFT growth. With the current trend of decreasing fuel costs,[148] flight schools, especially Part 141 flight schools, should focus on capacity growth by keeping other costs in check and not automatically initially increasing profits.

Two/four-year school partnerships

There is advantage from an hour-building perspective for a pilot to train at a Part 141 flight school associated with a two-year college or a four-year university. The 250/500-flight hour credit provided by this training is a significant recruitment tool. There are opportunities for Part 141 flight schools to enter into discussions with local two-year colleges or four-year universities on partnerships in order to take advantage of these R-ATP flight hour credits. There are opportunities for Part 61 flight schools to transition to a Part 141 flight school and pursue these same partnerships.

Partnerships with minors

While most large flight schools have already established bridge programs with regionals, there are opportunities for smaller flight schools to do the same. Larger flight schools with established with bridge programs can also expand the number of regionals involved in their bridge programs.

---

[148] http://www.bloomberg.com/news/2014-09-25/cheaper-energy-to-grain-signaling-tame-inflation-for-u-s-.html

Partnerships with commercial node

Flight schools can investigate establishing bridge programs with Part 135 operators that require ATPs, Part 91(K)s and Part 125 operations. There is a danger of having too many CFIs for the student load, and creating a snowball effect where CFIs cannot generate enough flight time to move on to the next career step. As attendance in flight schools increase, these bridge programs for commercial rated pilots can help ease the burden of carrying CFIs trying to build 1000+ hours of flight time to enter regional bridge programs.

Government (DOT/FAA)

Safety trend surveillance at the minors, commercial, and instructional nodes

As the supply of qualified pilots and the demand converge, some companies may need to relax hiring requirements. Whereas five years ago companies may not have hired pilots with issues such as recent DUIs, previously failed checkrides, or low educational grade point averages, there may be a trend to hire those pilots as the pool of applicants shrinks. These changes in hiring do not necessarily mean there will be a decrease in safety, but it does mean the demographic of pilots flying these aircraft may change slightly. The FAA continuously monitors safety-related trends in all aviation sectors. All large operators from Part 141 flight schools to the Part 121 majors also implement safety and training trend analysis in their required safety and training programs. The first indicators there is a shift in safety or training failure trends will occur at the operator level. FAA pilot checkride trends, especially for Part 135, 91(K), 125, and 121 minors, will also provide valuable information as to whether a negative trend in pilot performance is developing. Trends in these data are currently captured and analyzed by the FAA. The importance of frequent updates and horizontal and vertical information sharing up to the highest levels of administration cannot be overstated. This trend information will inform the FAA and DOT whether there are any unintended consequences from the recent legislative changes, or safety related impacts from the increase in major airline hiring.

Pilot wages and EAS subsidies

Two major studies (GAO and MITRE) have connected pilot supply to pilot minimum wages. Part 121 (and in some cases Part 135 operators) bid for $226M in EAS contracts to service 117 designated cities in the United States, and $14M to service 43 designated cities in Alaska.[149] Many operators in this program offer some of the lowest wages in the industry to keep labor costs low to help win the program bids. As mentioned above, the largest provider of EAS service in the United States, Great Lakes, offers an industry-low $16/hour starting wage, with

[149] http://www.dot.gov/sites/dot.gov/files/docs/Subsidized%20EAS%20report%20for%20communities%20in%20Alaska-Jun%202014.pdf

$58M in 2012 contracts comprising 42 percent of their annual revenue.[150] As pilot demand has increased over the last year, the result has been a major pilot exodus from Great Lakes forcing them to drop many EAS contracts and disrupting travel as the DOT scrambled to find other operators to fill those contracts. Creating a minimum wage for EAS bids based on the industry average of the top five regionals would increase the number of higher paying pilot jobs, which in turn would increase the overall pilot supply by enticing those pilots who left the pilot pipeline to find higher paying employment to re-enter the pilot pipeline.[151]

MPL licensing

The International Civil Aviation Organization (ICAO) is a UN specialized agency that "works with the Convention's 191 Member States and global aviation organizations to develop international Standards and Recommended Practices (SARPs) which States reference when developing their legally-enforceable national civil aviation regulations."[152] Each member state's national civil aviation authority (the FAA in the United States) approves its own pilot certification regulations. In 2006, ICAO introduced the Multi Crew Pilot License (MPL). This license was developed by the ICAO Flight Crew Licensing and Training Panel between 2001 and 2005, with participation of 18 member states and 5 international organizations, in an effort to update the pilot training process that had been in-place since the 1950s. According to the International Air Transport Association (IATA), the trade association for world 240 airlines, the MPL is designed to accomplish the following:

- Replace by competency-based training the traditional application of box-ticking, hours based, prescriptive syllabi
- Guide students seamlessly from ab-initio training to airliner type rating, using simulation designed for multi-crew training
- Address the increased rates of loss of control in airline operations through Upset Prevention and Recovery Training (UPRT)
- Combat the continuing dominance of multi-crew human factors in accidents through Threat and Error Management (TEM) and Crew Resource Management (CRM)
- Mitigate the prevalence of miscommunication with Air Traffic Control (ATC)[153]

The MPL is an airline-sponsored *ab-initio* program tailored to a specific airline and country. The basic minimums for an MPL are 240 hours in a mix of aircraft and FSTD, and 12 takeoffs and landings.[154] Lufthansa, ANA, Qatar Airways, and AirBerlin are some of the 30 airlines now using this licensing program. Graduates of the program become first officers with the airline, but

---

[150] http://wyofile.com/gregory_nickerson/subsidair-essential-air-service-subsidy-great-lakes-airlines/

[151] According to 2013 MITRE study and 2014 GAO study.

[152] http://www.icao.int/about-icao/Pages/default.aspx

[153] http://www.iata.org/whatwedo/ops-infra/itqi/Pages/mpl.aspx

[154] http://www.aabi.aero/News&Calendar/july2012/presentations/1%20%20MPL%20Marquis.pdf

are not eligible for upgrade to captain until they reach 1500 hours.[155] Examining the 25 MPL courses that IATA tracks, the average flight time of new FOs on graduation is 88 hours, and average FSTD hours is 195 hours.[156] Lufthansa, a major global airline and a member of the Star Alliance along with United Airlines, participates in a MPL course consisting of 99 hours of flight training and 213 hours of FSTD training. The clear question is why the minimum requirement for a FO on a major European airline and U.S. airline differs so drastically.

This licensing program is new, and there are not enough data yet to determine the effectiveness or shortcomings of this new training regime. Many organizations are not yet convinced the quality of training meets requirements for safe operations, including the International Federation of Air Line Pilots' Associations (IFALPA). "Even in well-managed MPL training programs, several key areas of pilot professional development need increased focus and improvement. Specifically, they are: basic flying skills, airmanship, cockpit resource management, and air traffic control situational awareness"[157]. They point to the lack of actual aircraft flying, takeoff/landings, and communications with air traffic control. On the other hand, many industry insiders have stated the "1500" hour rule does little in itself to address the issues brought to light by the 2009 Colgan accident. Former FAA Administrator and ALPA President Randy Babbitt said:

> One of the things that the Call Action has also shown a light on is the issue of varying operational experience. We do not believe that simply raising quantity – the total number of hours of flying time or experience – without regard to the quality and nature of that time and experience – is an appropriate method by which to improve a pilot's proficiency in commercial operations. For example, a newly-certificated commercial pilot with the minimum number of hours might be limited to certain activities until he or she could accumulate the type of experience deemed potentially necessary to serve as a first officer for an air carrier. Such experience would need to include training and operational experience in the multi-pilot environment, as well as training and exposure to icing, high altitude operations, and other areas common to commercial air carrier operations.

In fact, in the FAA's own Notice of proposed rulemaking for the *Pilot Certification and Qualification Requirements for Air Carrier Operations*, the FAA stated:

> The FAA's Office of Accident Investigation and Prevention (AVP) found little relationship between the 1500-hour requirement and airplane accidents. Only 7 of the 31 accidents used for the part 121 benefit analysis had SICs with less than 1,500 hours. Moreover, the NTSB reports on these seven accidents indicate other issues addressed by the proposed rule.(FAA 2012)

---

[155] Minimum for an Airline Transport Pilots License (ATPL), required by most European and Asian countries.

[156] http://www.iata.org/whatwedo/ops-infra/itqi/Pages/mpl.aspx

[157] http://www.ainonline.com/aviation-news/farnborough-air-show/2014-07-13/ifalpa-flags-concerns-over-mpl-training

Proponents of the MPL program often refer to military pilot training, where pilots are trained to fly as the equivalent of first officers in large aircraft such as the C-17 and C-5 in as little as 300 hours.[158] The problem with this analogy is that a civilian can obtain a commercial certificate in the United States with no simulator time, whereas the military incorporates extensive training in simulators in addition to the flight time as part of their training.

An option is to adopt elements of the MPL (with integrated ATP CTP) on top of the requirements of a US commercial certificate with instrument rating as valid training for first officers on Part 121 regional aircraft (less than 100-seats). This option would ensure at least 250 hours of actual flight time, but would also incorporate all of the training innovations developed as part of the MPL program. The MPL program already includes the elements added by the new ATP CTP requirement.[159] The commercial certificate with instrument rating already includes many MPL training requirements. Thus, the change from the old Part 121 FO requirement, commercial certificate with instrument rating, to the new "1500-hour" rule:

1) Would not be as drastic a flight hour/time/money increase without guaranteeing it addresses the underlying issues that initiated the rule change

2) Would specifically target the inherent issues found as causal factors in the 2009 Colgan air accident

This combined commercial certificate with instrument rating/MPL, which could be referred to as an advanced pilot (AP) certificate, would more closely mirror the military flight school and subsequent formal training unit process. The AP certificate would only apply to Part 121 operations flying regional aircraft.

Table 6.2. Proposed Certificate Requirements

	Part 135[160]/91(K)		Part 121 < 100 seats		Part 121 ≥ 100 seats	
	PIC	SIC	PIC	SIC	PIC	SIC
Proposed Certificate Requirement	ATP	Commercial with Instrument	ATP	US AP or R-ATP	ATP	R-ATP
Comparison to Current Requirement	No change	No change	No change	Change	No change	No change

The FAA would develop an AP certificate that removed the portions of the MPL already covered by the commercial certificate with instrument rating, which would be a prerequisite for the AP. The ATP CTP training, which is a current prerequisite for the R-ATP, would already be included in the AP certificate training as that information is already covered in the MPL. The

[158] Pilot training plus formal training unit (FTU) specific aircraft upgrade

[159] See Appendix F for the MPL training scheme

[160] Flying commuter operations using multiengine airplanes with ≤ 9 passenger seats, on-demand operations using multiengine airplanes with ≥ 10 passenger seats , or turbojets

end result would be that flight students could be hired by Part 121 regionals within a year after completion of their commercial certificate with instrument rating.

Another aspect of the MPL is that each program is specifically tailored for a specific airline. The airline is involved in developing the specifics of the program along with the host country and ICAO. Thus, a Lufthansa MPL-trained pilot cannot leave the company and fly for Emirates Air until completion of their Initial Operating Experience phase (IOE) and their first line check.[161] Although this study found no evidence of large numbers of U.S. pilots leaving the pipeline to fly for airlines in other countries, AP certification could act as a buffer since it would only be recognized in the United States, and would ensure AP certificated pilots initially stayed within the U.S. pipeline.

Age 67 Mandatory Retirement

In April 2015, the Civil Aviation Bureau in Japan is expected to raise the mandatory retirement age for their pilots to 67. This would only apply to domestic flight operations, since ICAO regulations still impose a max age of 65 for international commercial air transport operations[162]. The Civil Aviation Safety Authority in Australia allows pilots to fly domestic airlines through age 70[163]. The Civil Aviation Authority in Canada also allows pilots to fly past age 65, but only in the FO position.

As discussed earlier, even if the U.S. pilot pipeline is currently in equilibrium (which this study does not assume), no actual numerical shortages are predicted until after 2019. If the worst case happens and not enough qualified pilots are available to fill the number of available seats in cockpits, the FAA could consider raising the current mandatory retirement age to at least 67. By 2019, there will be enough data points from other countries to determine if this policy change would have a negative effect on safety.

Mandatory retirements in the United States in 2020 will approach 2500 pilots/year, increasing to over 3000 pilot/year by 2021. Raising the retirement age in 2019 by two years would temporarily decrease the demand at the majors, and subsequently slow the flow of the pipeline and decrease demand throughout the entire pipeline. As shown in the 2012 Delta study, not all pilots fly until his or her mandatory retirement age. If pilots retired at the same pace after age 65 as they do before age 65, the demand in the pipeline would only decrease by approximately 2000 pilots over that two-year age extension period.

The change in mandatory retirement age is an option if the U.S. pilot pipeline experiences a true shortage. If this situation occurs and pilot production is not increased, this policy option will only push the shortage to the right approximately 2 years. This policy change would only apply

---

[161] Flight evaluation

[162] http://www.icao.int/safety/aviation-medicine/Pages/medFAQ_en.aspx

[163] http://www.casa.gov.au/scripts/nc.dll?WCMS:STANDARD::pc=PC_102197

to pilots flying domestically within the United States, unless ICAO changes their international maximum age rules.

---

7. Policy Recommendations

This chapter provides recommended policy changes for civilian operators at the majors, minors, commercial, and instructional nodes, the military services, and U.S. government agencies. These policy changes will decrease the strain that major airline hiring will place on the U.S. pilot pipeline, will minimize potential pilot inventory shortages in the U.S. military, and address potential safety concerns caused by the pilot hiring increase.

Majors

Expand SSP and/or flow-through agreements

Based on expected hiring, majors should take the following steps:

- Expand SSP and/or flow-through agreements with owned-regionals, similar to the Endeavor-to-Delta Pilot Hiring Program[164]
- Connect owned-regional flight school bridge programs with regionals to major SSP or flow-through agreements to offer a "cradle-to-grave" career path for new pilots
- Establish bridge/guaranteed interview agreements with larger Part 135 operations requiring ATPs and Part 91(K) operations flying larger turbines.

Minimize upgrade/flow-through times at owned regional(s)

The economic advantage of moving to the majors earlier far outweighs pay raises at the regional, which is a significant recruiting tool that can be used to attract the most qualified applicants.

This recommendation only applies to network majors that count on feeder regionals for a portion of their passenger share. Some majors, such as Southwest, employ a different business model, and thus do not count on feeder regionals for their passenger base.

Lobby for changes to Uniformed Services Employment and Reemployment Rights Act

This study recommends discussion between the Department of Defense, the major airlines[165], and the pilots union, ALPA[166], to find a mutually agreeable process to address four concerns:

1) Outside of declared war or national emergency, require a minimum period of notice to the airlines when Guard/Reserve members go on military leave

[164] http://www.endeavorair.com/documents/EtD_Program_Website.pdf

[165] Airlines for America (A4A), the trade organization representing principle US airlines, would be the primary contact

[166] Air Line Pilots Association

2) Require some threshold of need by the Guard/Reserve headquarters for cumulative military leave above an agreed-upon level
3) Give the airlines an avenue of recourse to pursue if they feel there is a case of Guard/Reserve members or units abusing the spirit and intent of USERRA privileges
4) Investigate the feasibility of scheduling most known Guard and Reserve deployments away from summer months and major holidays when airline pilot manning is critical

Minors

Limit new-hire employee departures

Options for regionals to limit loss of new-hire employees include the following:

- Secure agreements for the newer aircraft (such as the E175 or CRJ 900), thus indicating a stable future
- Offer a robust and shortened SSP or flow-through agreement with a major. The shorter the timeline from regional new-hire to majors new-hire, the greater the incentive to stay at the regional.
- For independent regionals, offering flow-through or bridge agreements with multiple majors offers new-hires more options. This is especially true if a pilot, for family or quality-of-life reasons, desires to live in a specific location co-located with a hub of specific major.
- Offer retention incentives as discussed below

Implement recruitment and retention incentives

Since the minor node includes a wide range of operators, different incentives will best fit different operators. Implementation of at least one of the following three options, along with a robust SSP or flow-through program, can ensure recruitment of "best available" candidates and retention of these pilots through the critical first three years.

- Offer signing bonuses
- Offer an annual retention bonus for the first four years of employment
- Offer a provident fund equal to a percentage of pilot pay for each of the first four years of employment, payable only after four years of employment

Match industry-high payscales

For those regionals that offer wages below the average of others, raising their wages in line with the industry leaders will increase their current supply of applicants.

Combine Part 121/135 operation

Smaller regionals, such as those that fly very low load-factor routes as part of the EAS program, can benefit from a combined Part 121/135 program.

- Operating costs will be lower by flying higher load factors on smaller aircraft.
- Airlines can hire commercial pilots, and create an intra-company flow-through from Part 135 to Part 121, followed by a flow-through to the majors.
- An added longevity incentive would be to offer an in-house ATP CTP after a given length of employment

Expand bridge agreements with flight schools and Part 135 operators

Where feasible, bridge agreement (guaranteed interviews) should be extended to almost every Part 141 flight school, many Part 61 flight schools, and many Part 135 operators.

Combine bridge and SSP/flow-through programs

For regionals with established SSP or flow-through programs to the majors, combine flight school bridge programs with the majors SSP/flow-through program to create a "cradle-to-grave" career path for new pilots.

Part 135 and Part 91(K) establish bridge agreements with majors

Bridge agreements can work as recruiting tools for commercial pilots, offering them a known career path from commercial-rated FO, to an intra-company upgrade to ATP and a captain position, to an interview with a major after a specified period of time serving as a captain.

Military

The number of forecast separations from the military due to major airline hiring is unsustainable within the next five years. Based on the very significant relationship between USAF pilot separations/retirements and major airline hiring, and USN fixed-wing losses and major airline hiring, this study recommends the following actions.

Increase fixed-wing pilot production

Based on the forecast, this study recommends the USAF increase pilot production to the maximum possible with current pilot and aircraft inventories, to 1100/year[167] by FY19.

This study did not have access to reliable fixed-wing pilot production maximum numbers for the USN, thus no specific number recommendation is made. This study does, though, recommend the USN be prepared to increase fixed-wing pilot production by FY17 in response to the more immediate inventory shortage forecast.

[167] See page 66 for discussion. Upper bound of RegAF pilot production possible with current force structure per HQAF TFAM

Increase ACP

This study recommends the military services gain OSD authority to raise the ACP offering up to 100 percent of current ACP authorization based on the recommendations of the *Modeling the Departure of Military Pilots from the Services* study. If separations and retirements track with the forecast between FY14 and FY18, this study recommends the military services be prepared to increase the ACP as required by the recommendation in an updated *Modeling the Departure of Military Pilots from the Services* study.

In the interim, the services should increase the ACP offering to the previously approved and offered contract of $25K/year, until 20 or 25 years-of-service, with 50 percent up front.

The military should also research other ACP options such as giving the bonus to O-1s starting immediately after pilot training for five years if they agree to a 15-year ADSC.

Increase ACIP

The services should gain authorization to raise the ACIP to FY99 equivalent inflation-adjusted levels ($1190/month in FY14), and index future annual increases to the CPI.

Study the implications of shifting force structure to the Guard/Reserves

While shifting force structure to the Guard/Reserves may allow the military to retain pilots who separate for the major airlines, other aspects of this policy change require additional study. The most important aspect would be whether the shift in force structure could meet the current and future projected steady-state and surge warfighting requirements. Additionally, there would be issues with absorption, requiring expansion of Active-Reserve associate programs. A 2014 RAND study, *Suitability of Missions for the Air Force Reserve Components*, provides insight into these specific issues. This study should be updated and expanded to include the USN, with a specific focus on these issues.

Study the implications of ADSC changes

There is not enough data yet to reliably predict the results of the FY00 ADSC change from eight to ten years[168]. In the next few years, analysis of this ADSC change can inform whether a future change in ADSC to 12 years or adding a decreased RegAF to ANG/AFR ADSC option, as described in the previous chapter, is appropriate to limit future military pilot separations. This recommendation also applies to the USN.

Commercial

Larger commercial operators should mimic recent efforts by Part 141 flight schools to establish bridge agreements with the regionals. Commercial operations that also require ATPs

[168] The first cohort of pilots, FY00, affected by this change entered their separation window in FY11 and FY12.

(thus straddling the commercial and minors node) already have the ability to offer upgrades to ATPs and captains as a recruitment tool.

Implement recruitment and retention incentives

Similar to regionals, commercial operators that experience difficulty recruiting and retaining pilots as demand increases should implement signing bonuses to attract "best qualified" candidates, and retention incentives such as annual retention bonuses or retention bonuses that pay out after a given length of employment.

Instructional

Flight schools can increase enrollment in their programs by taking the following steps:

- Find ways to limit CFT growth, especially given the current trend of decreasing fuel costs.
- If a Part 141 flight school, investigate the option of creating an aviation degree program with a local two-year college or four-year university to take advantage of the 250/500-hour credit offered.
- If a Part 61 flight school, investigate the possibility of transitioning to a Part 141 flight school and developing a similar partnership with a local college or university.
- Enter into bridge programs with regionals. Those with current bridge programs should expand the number of regionals involved in their bridge programs.
- Establish bridge programs with Part 135 operators that require ATPs and Part 91(K)s

Government (DOT/FAA)

Increase safety trend surveillance at the minors, commercial, and instructional nodes

The FAA should expand their safety-related leading indicator surveillance program, used to identify any negative safety or training trends at the operator level. This expansion should focus on the minors and commercial nodes. Any negative trends should be identified immediately, briefed at the highest administration levels, and action taken as appropriate.

Include minimum pilot wages as part of EAS subsidies

As long as the EAS program remains a functioning government subsidy, the DOT should consider a minimum hourly wage, equal to the average base pay of the regionals, as a stipulation in competing for EAS contracts.

Research MPL licensing

This study recommends the FAA formally study the option of adopting elements of the MPL (with integrated ATP CTP) on top of the requirements of a U.S. commercial certificate with

instrument rating as valid training for first officers on Part 121 regional aircraft (less than 100-seats).

This combined commercial certificate with instrument rating/MPL, referred to as an advanced pilot (AP) certificate, would more closely mirror the military flight school and subsequent formal training unit process. The AP certificate may provide a quicker, less costly, and more targeted approach to addressing the previous FAA rule shortcomings than the "1500-hour" rule.

Research raising the mandatory retirement age to 67

If the worst case happens and a true pilot shortage appears toward the end of this decade, the FAA will be prepared to lobby for and implement this policy change.

---

8. Issues for Further Consideration

This chapter raises some additional issues that warrant further consideration. It deals with the following questions:

- Given that other countries require far fewer flight hours to qualify as an airline pilot, is the FAA minimum valid?
- Is the two-pilot requirement for Part 121 operators valid?
- Is it possible to reduce crew size on cargo aircraft?

The chapter also suggests some additional studies that should be done.

Validity of FAA minimum requirements

FAA minimum Part 121 FO basic requirements are 1500 hours flight time plus the ATP CTP. Worldwide major airlines have drastically different minimum requirements for FOs. Lufthansa minimum equivalent requirements for a FO are a MPL license with 99 hours of flight time and 213 hours of FSTD time; Qatar Airways is 86 hours flight time and 220 hours of FSTD time; ANA is 102 hours flight time and 149 hours FSTD time.[169] British Airways will begin participating in the MPL licensing program in 2015.[170] Before the implementation of the "1500 hour" rule, U.S. Part 121 aviation was already far safer than the world average. 2013 was the safest year on record for world airlines, with an accident rate of 2.8 per one million departures.[171] U.S. Part 121 airlines averaged an accident rate of only 0.029 per one million departures over the last 10 years[172], a rate 100 times lower than the 2013 global average. This study recommends the FAA track safety metrics for U.S. Part 121 airlines, Part 135 operations requiring an ATP, and Part 91(K) operations to determine if the new rule changes equate to better safety statistics. Additionally, the FAA should closely track the safety performance of MPL graduates to determine if this training improves performance. These data will help inform whether minimums should be changed in the future and if the concept of an AP certification should be pursued.

[169] http://www.iata.org/whatwedo/ops-infra/itqi/Pages/mpl.aspx

[170] http://www.britishairways.com/careers/futurepilot/fppProgramme.shtml

[171] http://www.icao.int/safety/documents/icao_2014%20safety%20report_final_02042014_web.pdf

[172] https://www.ntsb.gov/data/aviation_stats.html

Single Pilot Part 121 Operations

Smaller Part 135 operators are authorized to carry paying passengers with a single pilot, and are authorized to fly those passengers in IMC conditions with an autopilot in-lieu-of a SIC. The FAA does not authorize this same type of operation for Part 121 operators carrying paying passengers. Thus, the FAA authorizes Part 135 operators using a single pilot to carry paying passengers in single-engine aircraft with typically older electronics and less redundancy, but does not authorize Part 121 operators to fly with a single pilot when carry paying passengers in larger, multi-engine turbojet aircraft often with newer electronics and more robust redundancy. Obviously the consequences an accident involving an aircraft carrying 250 passengers differs from an aircraft carrying six passengers, but the incongruity remains.

The most significant change in Part 121 single pilot operations would not be with the FAA, but with the travelling public, which usually expects two pilots flying their aircraft. In 2014, NASA commissioned a study on this concept with Rockwell Collins to investigate the possibilities of implementing this concept.[173] The effect on the U.S. pilot pipeline would be major, even if the rule applied only to Part 135, Part 125, Part 91(K), and minors Part 121.

Reduced crew/Single Pilot/Unmanned Cargo Flights

As an extension of the previous discussion, cargo carriers may be an acceptable first step in the evolution towards reduced crew passenger flights. The following lists a logical progression towards an approved baseline of reduced crews in cargo-only operations

- Reduced crews for international overwater flights taking off and landing from coastal airports. In the early 2000s, FedEx approached the FAA with the idea of reduced crews on these types of flights[174]. These flights currently require a relief pilot because of the length of the flights. For this recommendation, both pilots would be required for takeoff and landing, but the pilots could take turns resting during the overwater portions of flight, eliminating the need for the third pilot.
- Single pilot operations for all Part 135 cargo-only flights
- Single-pilot operations for all Part 121 cargo-only flights flying routes into unpopulated areas or into populated areas with routes designed to minimize overflight of populated areas
- Unmanned cargo-only Part 135 flights into unpopulated areas

Decreasing the pilot requirement will obviously result in a decreased strain on the U.S. pilot pipeline.

[173] http://www.wsj.com/articles/single-pilot-cockpits-floated-in-nasa-study-1418611930

[174] http://www.wsj.com/articles/single-pilot-cockpits-floated-in-nasa-study-1418611930

Future studies

The following recommended future studies will add to this research and improve understanding of and implementation of suggested policy options:

- Feasibility of scheduling Guard and Reserve deployments away from summer months and major holidays

- Number of separating and retiring military pilots who subsequently fly for the airlines

  While historical data exist on the percentage of military pilots in the ANG and AFR who also fly for the airlines, there are no good current data sources. This study should seek to explore the following issues:

  - Percent of separating and retiring pilots who seek employment with the airlines.
  - Percent of Guard and Reserve pilots who are also employed by the airlines
  - The characteristics of previous military pilots, if any, who fly for the regionals
  - Suggestions from separated pilots who fly for the airlines on what the military could have done to keep them from separating

- Update 2004 RAND study *Modeling the Departure of Military Pilots from the Services*
  - Based on changes in military compensation and airline pay and benefits, what are the new estimations on the required ACP and ACIP increases to manage pilots' separations, especially in light of major airline hiring increases?
  - Expand to include the USN

- Update 2014 RAND study *Suitability of Missions for the Air Force Reserve Components*
  - What are the implications of shifting force structure from the RegAF to the Guard/Reserves from both a warfighting and manpower perspective
  - Expand to include the USN

- Understanding the effects and limitations of flow-thru and bridge agreements
  - What are the characteristics of successful flow-through and bridge agreements?
  - Do these agreements change pilot decisions on which regional they choose for employment
  - Is quicker flow-through the most important recruiting tool from the perspective of new-hire pilots?

- Understanding the number of U.S. citizens who fly for foreign carriers and associated trends
  - How many U.S. pilots (commercial and ATP) fly for foreign-based airlines

        - What were the most important reasons why these pilots chose to leave the U.S. pipeline and fly for a foreign-based carrier
        - What percentage of these pilots plan to return to the U.S. pipeline after their "contract" has completed
- Safety trends as the difference between the supply of pilots and the demand for pilots converges
        - Are there any negative safety trends as airlines (especially at the minors and commercial nodes) hire from a diminishing pool of applicants
        - If any negative safety trends are identified, determine any commonalities in the previous training of these pilots that correlate to these negative trends
        - Identify ways to improve these deficiencies in training

---

Appendix A. Mathematical Models for Supply and Demand

Pilot Demand

This section discusses the mathematical model used to determine the pilot demand at each of the nodes:

- $D^{135}_{t,a}$ = Pilot Demand for Part 135 commercial, Charter, or Corporate operation in time, t, for a specific operation, a
- $D^{121R}_{t,a}$ = Pilot Demand for Part 121 regional airline operation (e.g., SkyWest) in time, t, for a specific airline, a
- $D^{121M}_{t,a}$ = Pilot Demand for Part 121 major airline operation, including both Network (e.g., Delta), Domestic (e.g., Southwest), and Cargo (e.g., FedEx) carriers in time, t, for a specific airline, a

Terms

$NP^{135,121R,121M}_{t,a}$ = New pilot requirement due to fleet growth at that node in time, t, for a specific operation or airline, a

$LP^{135}_{135,121R,121M,125,\ Ret,\ Intl,\ Oth,\ Fur,\ t,a}$ = Loss pilot, at superscript node, for subscript reason, in time, t, for a specific operation or airline, a

- 135 = Part 135 commercial, Charter, or Corporate operation
- 125 = Part 125 operation (e.g., Corporate B-737)
- 121R = Part 121 regional airline operation (e.g., SkyWest)
- 121M = Part 121 major airline operation, including both Network (e.g., Delta), Domestic (e.g., Southwest), and Cargo (e.g., FEDEX) carriers
- Intl = International operation (e.g., China Air)
- Ret = Retirement at age 65 at that node
- Oth = Loss pilot to Other, including career change, medical, early retirement, being fired, or unknown at that node
- Fur = Loss pilot to Furlough at that node

Pilot Demand Equations

The Pilot Demand (Pilot Flow) for a Part 135 commercial, Charter, or Corporate operation is:

$$D^{135}_{t,a} = NP^{135}_{t,a} + LP^{135}_{135,t,a} + LP^{135}_{Ret,t,a} + LP^{135}_{125,t,a} + LP^{135}_{121R,t,a} + LP^{135}_{121M,t,a} + LP^{135}_{Intl,t,a} + LP^{135}_{Oth,t,a}$$

By using simplifying assumptions[175]

[175] $LP^{135}_{135,t,a}$ is dropped since the Part 135 category is treated as a node, so transfers within that node do not affect the supply and demand external to the node.

$D^{135}_{t,a} = NP^{135}_{t,a} + LP^{135}_{121R,t,a} + LP^{135}_{121M,t,a} + LP^{135}_{Intl,t,a} + LP^{135}_{Oth,t,a}$

For the Part 135 Node (including simplifying assumptions)

$D^{135}_{t} = NP^{135}_{t} + LP^{135}_{121R,t} + LP^{135}_{121M,t} + LP^{135}_{Intl,t} + LP^{135}_{Oth,t}$

The Pilot Demand (Pilot Flow) for a Part 121 regional airline is:

$D^{121R}_{t,a} = NP^{121R}_{t,a} + LP^{121R}_{135,t,a} + LP^{121R}_{125,t,a} + LP^{121R}_{121R,t,a} + LP^{121R}_{121M,t,a} + LP^{121R}_{Intl,t,a} + LP^{121R}_{Ret,t,a} + LP^{121R}_{Oth,t,a} + LP^{121R}_{Fur,t,a}$

By using simplifying assumptions[176]

$D^{121R}_{t,a} = NP^{121R}_{t,a} + LP^{121R}_{135,t,a} + LP^{121R}_{121M,t,a} + LP^{121R}_{Intl,t,a} + LP^{121R}_{Ret,t,a} + LP^{121R}_{Oth,t,a}$

For the Part 121 regional airline Node (including simplifying assumptions)

$D^{121R}_{t} = NP^{121R}_{t} + LP^{121R}_{135,t} + LP^{121R}_{121M,t} + LP^{121R}_{Intl,t} + LP^{121R}_{Ret,t} + LP^{121R}_{Oth,t}$

The Pilot Demand (Pilot Flow) for a Part 121 major airline is:

$D^{121M}_{t,a} = NP^{121M}_{t,a} + LP^{121M}_{125,t,a} + LP^{121M}_{121M,t,a} + LP^{121M}_{Intl,t,a} + LP^{121M}_{Ret,t,a} + LP^{121M}_{Oth,t,a} + LP^{121M}_{Fur,t,a}$

By using simplifying assumptions[177]

$D^{121M}_{t,a} = NP^{121M}_{t,a} + LP^{121M}_{Ret,t,a} + LP^{121M}_{Oth,t,a}$

For the Part 121 major airline Node (including simplifying assumptions)

$D^{121M}_{t} = NP^{121M}_{t} + LP^{121M}_{Ret,t} + LP^{121M}_{Oth,t}$

$LP^{135}_{Ret,t,a}$ is a valid path but not realistic in almost all cases since these pilots rarely end up spending an entire career at this level. After building hours, most pilots at this level are easily employable by a regional or major carrier, which offer much higher wages and benefits in most cases.

$LP^{135}_{125,t,a}$ is a valid path but the numbers of Part 125 registered aircraft is insignificant compared to the number of Part 135 aircraft so it is not included in the calculation.

[176] $LP^{121R}_{125,t,a}$ is a valid path, but the numbers of Part 125 registered aircraft is inconsequential compared to the number of regional Part 121 aircraft so it is not included in the calculation.

$LP^{121R}_{121R,t,a}$ is dropped, since the Part 121 regional airline category is treated as a node, so transfers within that node do not affect the supply and demand external to the node.

$LP^{121R}_{Fur,t,a}$ is a valid path, but the net result is assumed to be 0, since those pilots are the first to be called back to the airline before gains or losses external to that node.

[177] $LP^{121M}_{125,t,a}$ is a valid path, but the numbers of Part 125 registered aircraft is negligible compared to the number of major Part 121 aircraft, so it is not included in the calculation.

$LP^{121M}_{Intl,t,a}$ is dropped because once pilots are employed at the majors, they will lose their seniority position if they leave

$LP^{121M}_{121M,t,a}$ is dropped, since the Part 121 regional airline category is treated as a node, so transfers within that node do not affect the supply and demand external to the node.

$LP^{121M}_{Fur,t,a}$ is a valid path but the net result is assumed to be 0, since those pilots are the first to be called back to the airline before gains or losses external to that node

Pilot Supply

This section discusses the mathematical model used to determine the pilot supply at each of the major nodes:

- $S^{135}_{t,a}$ = Pilot Supply for Part 135 commercial, Charter, or Corporate operation in time, t, for a specific operation, a
- $S^{121R}_{t,a}$ = Pilot Supply for Part 121 regional airline operation (e.g., SkyWest) in time, t, for a specific airline, a
- $S^{121M}_{t,a}$ = Pilot Supply for Part 121 major airline operation, including both Network (e.g., Delta), Domestic (e.g., Southwest), and Cargo (e.g., FEDEX) carriers in time, t, for a specific airline, a

Terms

- SP^{Acc} = New pilot from accredited AU or TP
- SP^{Oth} = New pilot from non-accredited TP or FBO
- SP^{AccCFI} = New pilot CFI from accredited AU or TP with 1000 hrs
- SP^{OthCFI} = New pilot CFI from non-accredited TP or FBO with 1500 hrs
- SP^{135} = New pilot from Part 135 commercial, Charter, or Corporate operation
- SP^{125} = New pilot from Part 125 operation (e.g., Corporate B-737)
- SP^{121R} = New pilot from Part 121 regional operation (e.g., SkyWest)
- SP^{121M} = New pilot from Part 121 major airline operation, including both Network (e.g., Delta), Domestic (e.g., Southwest), and Cargo (e.g., FEDEX) carriers
- $CP^{F}_{121R,121M}$ = Loss pilot to Furlough at that node
- SP^{Intl} = New pilot from International operation (e.g., China Air)
- SP^{ADMil} = New pilot from AD Military
- SP^{RCMil} = New pilot from RC Military

Pilot Supply Equations

The Pilot Supply for a Part 135 commercial, Charter, or Corporate operation $(P^{S}_{135})_t$ is:

$$(P^{S}_{135})_t = (SP^{Acc} + SP^{Oth} + SP^{AccCFI} + SP^{OthCFI} + SP^{135} + SP^{125} + SP^{121R} + SP^{121M} + CP^{F}_{121R} + CP^{F}_{121M} + SP^{Intl} + SP^{ADMil} + SP^{RCMil})_t$$

By using simplifying assumptions[178]

---

[178] SP^{135} is dropped since the Part 135 category is treated as a node, so transfers within that node do not affect the supply and demand external to the node.

SP^{125} is a valid path but the numbers of Part 125 registered aircraft is negligible compared to the number of Part 135, or regional/major Part 121 aircraft so it is not included in the calculation.

SP^{121R}, SP^{121M}, CP^{F}_{121R}, CP^{F}_{121M}, SP^{Intl}, and SP^{ADMil}, and SP^{RCMil} are valid paths but not realistic in most cases since these pilots are easily employable by a regional or major carrier, which offer much higher wages and benefits in most cases.

SP^{RCMil} is only a realistic path for those in the RC who were not accessions from the Active Duty, i.e., they went directly from military pilot training into the RC. These pilots would not start out with enough hours to qualify for Part 121 operations and thus their only option for air transport is initially a Part 135 operation.

$(P^{S}_{135})_t = (SP^{Acc} + SP^{Oth} + SP^{AccCFI} + SP^{OthCFI} + SP^{RCMil})_t$

The Pilot Supply for a Part 121 regional airline $(P^{S}_{121R})_t$ is:

$(P^{S}_{121R})_t = (SP^{Acc} + SP^{Oth} + SP^{AccCFI} + SP^{OthCFI} + SP^{135} + SP^{125} + SP^{121R} + CP^{F}_{121R} + SP^{Intl} + SP^{ADMil} + SP^{RCMil})_t$

By using simplifying assumptions[179]

$(P^{S}_{121R})_t = (SP^{AccCFI} + SP^{OthCFI} + SP^{135} + SP^{Intl} + SP^{RCMil})_t$

The Pilot Supply for a Part 121 major airline $(P^{S}_{121M})_t$ is:

$(P^{S}_{121M})_t = (SP^{135} + SP^{121R} + SP^{121M} + CP^{F}_{121M} + SP^{Intl} + SP^{ADMil} + SP^{RCMil})_t$

By using simplifying assumptions[180]

$(P^{S}_{121M})_t = (SP^{121R} + SP^{Intl} + SP^{ADMil} + SP^{RCMil})_t$

---

[179] SP^{Acc} and SP^{Oth} are no longer valid paths after August 2013 due to Public Law 111-216.

SP^{125} is a valid path but the numbers of Part 125 registered aircraft is negligible compared to the number of Part 135, or regional/major Part 121 aircraft so it is not included in the calculation.

SP^{121R} is dropped since the Part 121 regional airline category is treated as a node, so transfers within that node do not affect the supply and demand external to the node.

CP^{F}_{121R} is a valid path but the net result is assumed 0 since those pilots are the first to be called back to the airline before gains or losses external to that node.

SP^{ADMil} is a valid path but not realistic in almost all cases since those pilots are easily employable by a major carrier, which offers much higher wages and benefits in most cases.

[180] SP^{135} is a valid path, but not realistic in almost all cases since there is a plentiful supply of SP^{121R} who can fill these positions and who are already ATP trained and licensed.

SP^{121M} is dropped since the Part 121 regional airline category is treated as a node, so transfers within that node do not affect the supply and demand external to the node.

CP^{F}_{121M} is a valid path but the net result is assumed to be 0 since those pilots are the first to be called back to the airline before gains or losses external to that node.

Table A.1 Intranodal Demand – Part 121 Majors Passenger

Year	Start Fleet #	End Fleet #	New Pilots Required For Fleet Growth	Mandatory Retirements	Adjusted Mandatory Retirements	Attrition Other	FT/DT	Total Pilots	Total New Pilots
2015	3804	3853	694	1204	1755	266	0	53610	2715
2016	3853	3918	911	1374	1848	268	0	54304	3028
2017	3918	3973	752	1632	1991	272	0	55216	3014
2018	3973	4003	767	1791	2007	276	0	55967	3051
2019	4003	4018	373	2017	2219	280	0	56735	2872
2020	4018	4087	1071	2213	2384	284	0	57108	3739
2021	4087	4160	1200	2686	2668	286	0	58179	4153
2022	4160	4235	1155	2677	2674	291	0	59378	4120
2023	4235	4291	795	2868	2758	297	0	60533	3850
2024	4291	4340	725	2788	2708	303	0	61329	3737
2025	4340	4413	1076	2867	2707	307	0	62054	4089
2026	4413	4483	969	2868	2656	310	0	63130	3935
2027	4483	4530	594	2692	2503	316	0	64099	3413
2028	4530	4587	905	2825	2505	320	0	64693	3730

Table A.2 Intranodal Demand – Part 121 Majors Cargo

Year	Start Fleet #	End Fleet #	New Pilots Required For Fleet Growth	Mandatory Retirements	Adjusted Mandatory Retirements	Attrition Other	FT/DT	Total Pilots	Total New Pilots
2015	741	751	125	248	342	46	0	9391	514
2016	751	767	200	268	341	47	0	9591	588
2017	767	780	163	305	348	48	0	9754	558
2018	780	804	300	314	332	49	0	10054	681
2019	804	824	250	329	348	50	0	10304	649
2020	824	836	150	350	367	52	0	10454	569
2021	836	846	125	396	394	52	0	10579	571
2022	846	862	200	413	403	53	0	10779	656
2023	862	880	225	411	398	54	0	11004	677
2024	880	904	300	423	399	55	0	11304	754
2025	904	926	275	411	350	57	0	11579	682
2026	926	951	313	414	309	58	0	11892	680
2027	951	979	350	380	251	59	0	12242	660
2028	979	1010	388	384	214	61	0	12630	663

Table A.3 Intranodal Demand – Part 121 Minors Regionals, Small Charter, Small Cargo

2013 # Operators	62

Year	Start Fleet #	End Fleet #	New Pilots Required For Fleet Growth	Mandatory Retirements	Adjusted Mandatory Retirements	Attrition Other	FT/DT	Total Pilots	Total New Pilots
2015	2202	2185	-153	124	167	236	0	23466	251
2016	2185	2166	-166	142	176	235	0	23300	244
2017	2166	2156	-81	169	182	233	0	23220	335
2018	2156	2140	-140	185	211	232	0	23080	303
2019	2140	2140	18	208	235	231	0	23098	484
2020	2140	2130	-77	229	267	231	0	23021	420
2021	2130	2137	87	224	292	230	0	23108	610
2022	2137	2142	71	387	393	231	0	23179	695
2023	2142	2134	-54	336	386	232	0	23124	563
2024	2134	2130	-15	442	454	231	0	23109	670
2025	2130	2122	-55	515	490	231	0	23054	666
2026	2122	2115	-41	517	484	231	0	23013	673
2027	2115	2109	-32	558	495	230	0	22980	693
2028	2109	2108	12	579	490	230	0	22992	731

Table A.4 Intranodal Demand – Minors, Part 135/91(K) Requiring ATP, Part 125[181]

Year	Start Fleet #	End Fleet #	New Pilots Required For Fleet Growth	Mandatory Retirements	Adjusted Mandatory Retirements	Attrition Other	FT/DT	Total Pilots	Total New Pilots
2015	4114	4171	226	116	114	163	0	16496	502
2016	4171	4239	265	124	121	165	0	16761	551
2017	4239	4337	391	132	126	168	0	17152	685
2018	4337	4450	450	156	149	172	0	17602	770
2019	4450	4568	470	179	169	176	0	18072	815
2020	4568	4695	503	209	195	181	0	18575	879
2021	4695	4833	549	235	217	186	0	19124	951
2022	4833	4973	556	324	296	191	0	19679	1043
2023	4973	5118	576	328	297	197	0	20255	1069
2024	5118	5272	615	398	356	203	0	20870	1174
2025	5272	5435	648	444	393	209	0	21519	1250
2026	5435	5612	701	452	397	215	0	22220	1313
2027	5612	5795	728	479	416	222	0	22948	1366
2028	5795	5987	767	489	421	229	0	23715	1417

[181] Fleets for Part 135/91(K) only include those requiring ATPs as PIC, and all Part 125s

Table A.5 Intranodal Demand – Commercial, Part 135, 91(K), 125, Corporate

Year	Start Fleet #	End Fleet #	New Pilots Required For Fleet Growth	Mandatory Retirements	Adjusted Mandatory Retirements	Attrition Other	FT/DT	Total Pilots	Total New Pilots
2015	16242	16329	149	175	172	244	0	24540	565
2016	16329	16460	215	186	181	245	0	24755	642
2017	16460	16662	331	197	189	248	0	25086	767
2018	16662	16908	400	232	221	251	0	25486	872
2019	16908	17172	427	264	248	255	0	25913	930
2020	17172	17461	466	306	285	259	0	26380	1011
2021	17461	17785	521	340	314	264	0	26900	1098
2022	17785	18118	536	465	425	269	0	27436	1230
2023	18118	18476	572	467	422	274	0	28008	1269
2024	18476	18857	609	562	503	280	0	28618	1393
2025	18857	19274	666	622	552	286	0	29283	1503
2026	19274	19733	730	631	554	293	0	30013	1576
2027	19733	20225	780	663	576	300	0	30793	1657
2028	20225	20752	835	674	580	308	0	31628	1722

Table A.6 Intranodal Demand – Commercial, Part 91

2013 # Operators	245

Year	Start Fleet #	End Fleet #	New Pilots Required For Fleet Growth	Mandatory Retirements	Adjusted Mandatory Retirements	Attrition Other	FT/DT	Total Pilots	Total New Pilots
2015	1084	1077	-16	18	18	26	0	2574	27
2016	1077	1072	-13	19	19	26	0	2561	32
2017	1072	1067	-12	20	19	26	0	2549	33
2018	1067	1063	-10	23	22	25	0	2540	38
2019	1063	1059	-9	26	24	25	0	2531	41
2020	1059	1056	-7	29	27	25	0	2524	45
2021	1056	1054	-6	32	29	25	0	2518	49
2022	1054	1052	-4	43	39	25	0	2514	60
2023	1052	1051	-2	42	38	25	0	2512	61
2024	1051	1050	-2	49	44	25	0	2510	68
2025	1050	1051	1	53	47	25	0	2511	74
2026	1051	1053	4	53	46	25	0	2515	75
2027	1053	1055	7	54	47	25	0	2522	79
2028	1055	1059	9	54	46	25	0	2531	81

Table A.7 Intranodal Demand – Commercial, Part 137

2013 # Operators	1505

Year	Start Fleet #	End Fleet #	New Pilots Required For Fleet Growth	Mandatory Retirements	Adjusted Mandatory Retirements	Attrition Other	FT/DT	Total Pilots	Total New Pilots
2015	2871	2856	-15	23	23	33	0	3254	40
2016	2856	2849	-7	24	24	33	0	3247	49
2017	2849	2843	-6	25	24	32	0	3241	50
2018	2843	2841	-2	30	28	32	0	3238	58
2019	2841	2842	1	33	31	32	0	3239	64
2020	2842	2845	3	38	35	32	0	3242	71
2021	2845	2851	7	41	38	32	0	3249	77
2022	2851	2860	9	55	50	32	0	3258	92
2023	2860	2874	14	55	49	33	0	3272	96
2024	2874	2889	15	65	58	33	0	3287	105
2025	2889	2910	22	70	62	33	0	3309	117
2026	2910	2937	27	70	62	33	0	3336	121
2027	2937	2970	34	73	63	33	0	3370	131
2028	2970	3009	40	73	63	34	0	3410	136

Table A.8 Intranodal Demand – Instructional, Part 141/61

Year	Start Fleet #	End Fleet #	New Pilots Required For Fleet Growth	Mandatory Retirements	Adjusted Mandatory Retirements	Attrition Other	FT/DT	Total Pilots	Total New Pilots
2015	10283	10386	187	133	131	187	0	18903	505
2016	10386	10490	189	142	138	189	0	19092	516
2017	10490	10594	191	150	144	191	0	19283	526
2018	10594	10700	193	176	167	193	0	19476	553
2019	10700	10807	195	198	187	195	0	19670	576
2020	10807	10915	197	228	213	197	0	19867	606
2021	10915	11025	199	251	232	199	0	20066	629
2022	11025	11135	201	340	311	201	0	20266	712
2023	11135	11246	203	338	306	203	0	20469	711
2024	11246	11359	205	402	360	205	0	20674	770
2025	11359	11472	207	439	389	207	0	20880	803
2026	11472	11587	209	439	385	209	0	21089	803
2027	11587	11703	211	454	395	211	0	21300	816
2028	11703	11820	213	454	390	213	0	21513	816

Appendix B. US Operations Categorization

Majors Passenger	Majors Cargo	Majors Charter
DELTA AIR LINES INC	FEDERAL EXPRESS CORP	OMNI AIR INTERNATIONAL INC
UNITED AIRLINES, INC.	UNITED PARCEL SERVICE CO	ATLAS AIR INC
AMERICAN AIRLINES INC	KALITTA AIR LLC	
SOUTHWEST AIRLINES CO	SOUTHERN AIR INC	
US AIRWAYS INC	ABX AIR INC	
JETBLUE AIRWAYS CORPORATION	AIR TRANSPORT INTERNATIONAL INC	
ALASKA AIRLINES INC		
SPIRIT AIRLINES INC		
VIRGIN AMERICA INC		
FRONTIER AIRLINES INC		
HAWAIIAN AIRLINES INC		
ALLEGIANT AIR LLC		

Minors Passenger	Minors Passenger (Cont'd)	Minors Cargo
EXPRESSJET AIRLINES INC	DYNAMIC AIRWAYS LLC	NATIONAL AIR CARGO GROUP INC
SKYWEST AIRLINES INC	AMERISTAR AIR CARGO INC	SKY LEASE I INC
ENVOY AIR INC	AEKO KULA INC	LYNDEN AIR CARGO L L C
ENDEAVOR AIR	CARIBBEAN SUN AIRLINES INC	AMERIJET INTERNATIONAL INC
REPUBLIC AIRLINES INC	SWIFT AIR L L C	CENTURION AIR CARGO INC
AIR WISCONSIN AIRLINES CORPORATION	SIERRA PACIFIC AIRLINES INC	GULF AND CARIBBEAN CARGO INC
SHUTTLE AMERICA CORPORATION	ELITE AIRWAYS LLC	NORTHERN AIR CARGO INC
HORIZON AIR INDUSTRIES INC	RHOADES AVIATION INC	FLORIDA WEST INTERNATIONAL AIRWAYS INC
CHAUTAUQUA AIRLINES INC	PRESCOTT SUPPORT CO	AERO MICRONESIA INC
PSA AIRLINES INC	SKY KING INC	POLAR AIR CARGO WORLDWIDE INC
COMPASS AIRLINES LLC	KEY LIME AIR CORPORATION	MOUNTAIN AIR CARGO INC
MESA AIRLINES INC	EMPIRE AIRLINES INC	
PIEDMONT AIRLINES INC	RYAN INTERNATIONAL AIRLINES INC	
GOJET AIRLINES LLC	PENINSULA AIRWAYS INC	
TRANS STATES AIRLINES LLC	AVIATION SERVICES LTD	
CHAMPLAIN ENTERPRISES INC	TATONDUK OUTFITTERS LTD	
SILVER AIRWAYS CORPORATION	HYANNIS AIR SERVICE INC	
MN AIRLINES LLC	AERODYNAMICS INC	
NORTH AMERICAN AIRLINES	USA JET AIRLINES INC	
SEABORNE VIRGIN ISLAND INC	VISION AIRLINES INC	
MIAMI AIR INTERNATIONAL INC	GREAT LAKES AVIATION LTD	
ERA AVIATION INC	KAISERAIR INC	
TEM ENTERPRISES	USA JET AIRLINES INC	
FALCON AIR EXPRESS INC	PRESCOTT SUPPORT CO	
HAWAII ISLAND AIR INC	AVIATION SERVICES LTD	
KALITTA CHARTERS II LLC		

Both Part 121/135
PENINSULA AIRWAYS INC
VISION AIRLINES INC
TATONDUK OUTFITTERS LTD
EMPIRE AIRLINES INC
MOUNTAIN AIR CARGO INC
GREAT LAKES AVIATION LTD
PRESCOTT SUPPORT CO
HYANNIS AIR SERVICE INC
USA JET AIRLINES INC
KAISERAIR INC
AVIATION SERVICES LTD
KEY LIME AIR CORPORATION

Part 135/91(K)

NETJETS AVIATION INC
AMERIFLIGHT LLC
EXECUTIVE JET MANAGEMENT INC
AIRNET SYSTEMS INC
JET SOLUTIONS LLC
FLIGHT OPTIONS LLC
HYANNIS AIR SERVICE INC
TRAVEL MANAGEMENT COMPANY LTD
HAGELAND AVIATION SERVICES INC
CLAY LACY AVIATION INC
WIGGINS AIRWAYS INC
XOJET INC
EXECUTIVE FLIGHT SERVICES INC
JET AVIATION FLIGHT SERVICES INC
CORPORATE AIR
TWC AVIATION INC
DELTA PRIVATE JETS INC
GAMA CHARTERS INC
ROYAL AIR FREIGHT INC
JET LINX AVIATION LLC
MOUNTAIN AIR CARGO INC
EMPIRE AIRLINES INC
MARTINAIRE AVIATION LLC
WEST AIR INC
BEMIDJI AVIATION SERVICES INC
KEY LIME AIR CORPORATION
BARON AVIATION SERVICES INC
FLIGHT INSPECTION SERVICES
CENTRAL AIR SOUTHWEST INC
COBALT AIR LLC
JET SELECT LLC
GREAT LAKES AVIATION LTD
PRIESTER AVIATION L L C
WESTERN AIR CHARTER INC
WORLD CLASS AVIATION LLC
SUNSET AVIATION LLC
CSA AIR INC
PHOENIX AIR GROUP INC
AVJET CORPORATION
PIEDMONT HAWTHORNE AVIATION LLC
ALPINE AVIATION INC
BERRY AVIATION INC
AAR AIRLIFT GROUP INC
KENMORE AIR HARBOR INC
AERO CHARTER AND TRANSPORT INC
WISCONSIN AVIATION INC
GRANT AVIATION INC
KALITTA CHARTERS LLC
AMERISTAR JET CHARTER INC
SUPERIOR AIR CHARTER LLC
AIR METHODS CORPORATION
IBC AIRWAYS INC
FREIGHT RUNNERS EXPRESS INC
WRIGHT AIR SERVICE INC
CORPORATE FLIGHT MANAGEMENT INC
AERO AIR L L C
L J ASSOCIATES INC
BUSINESS AVIATION COURIER INC
EASTWAY AVIATION LLC
AIR CARGO CARRIERS LLC
BERING AIR INC
EXECUTIVE AIR CHARTER OF BOCA RATON
KEY AIR LLC
GENERAL AVIATION FLYING SERVICE INC
TALON AIR INC
MOUNTAIN AVIATION INC
WEST COAST CHARTERS INC
MAYO AVIATION INC
RUSTS FLYING SERVICE INC
AIR MEDICAL RESOURCE GROUP INC
SKY ONE HOLDINGS LLC
INTERNATIONAL JET AVIATION SERVICES INC
WING AVIATION CHARTER SERVICES LLC
RR INVESTMENTS INC
GRAND CANYON AIRLINES INC
CORPORATE AIR LLC
EAGLEMED LLC
CITATIONSHARES MANAGEMENT LLC
FLIGHTWORKS INC
SOUTH AERO INC
LAKE CLARK AIR INC
GUARDIAN FLIGHT INC
ARCTIC TRANSPORTATION SERVICES INC
ACE AVIATION SERVICES CORPORATION
FLIGHT CONCEPTS INC
TRADEWIND AVIATION LLC
SEAPORT AIRLINES INC
AIRBORNE INC
AVIATION ADVISOR INC
WESTERN AIRWAYS INC
BANKAIR INC
WARBELOWS AIR VENTURES INC
CLUB JET CHARTER LLC
SUBURBAN AIR FREIGHT INC
KEYSTONE AVIATION LLC
EXCELAIRE LLC
CORPORATE EAGLE MANAGEMENT SERVICES INC
WESTWIND AVIATION INC
ELITE AIR INC
SUPERIOR TRANSPORTATION ASSOCIATES INC
NORTHERN JET MANAGEMENT INC
NORTH AMERICAN JET CHARTER GROUP L L C
AIR CHARTER INC
AERO CHARTER INC
MARTINAIR INC

RVR AVIATION LLC
JET AIR GROUP INC
SANFORD MEDICAL CENTER
JET CENTER LTD
SOUTHEASTERN OHIO AIR SERVICE INC
JETPOOL LLC
SPECIAL SERVICES CORPORATION
K AND R AVIATION LLC
SUNDANCE AVIATION INC
KAMAKA AIR INC
THE WHITEWIND COMPANY
KENAI FLOATPLANE SERVICE INC
TREGO-DUGAN AVIATION INC
KENTUCKY AIRMOTIVE INC
ULTRAAIR LLC
KINGFISHER AIR SERVICES AIR SAFARI
WESTERN AIRCRAFT INC
ALTIUS AVIATION LLC
WINGS AIRWAYS INC
L-3 COMMUNICATIONS FLIGHT INTERNATIONAL AVIATION L
HELICOPTERS INC
AIR NEWPORT LLC
CHARTAIRE INC
KANSAS AIR CENTER INC
C C CALZONE LLC
KANTISHNA AIR TAXI INC
SCHUMAN AVIATION COMPANY LTD
CALIBER JET CHARTER LLC
STORM FLYING SERVICE INC
CALIFORNIA SHOCK-TRAUMA AIR RESCUE
TURBO AIR CHARTER LLC
KEY WEST SEA AND AIR LLC
RENAISSANCE JET INC
AIR S F FLIGHT SERVICE
CSG AVIATION LLC
ADVANCED AIR INC
AVIATION WEST CHARTERS INC
KOURY AVIATION INC
SPIRITJETS LLC
EL AERO SERVICES INC
SUPERIOR AVIATION LTD
CINCO AIR CHARTER LLC
JET SERVICES INC
LAKE AND PENINSULA AIRLINES INC
DENALI AIR INC
LAKE PLACID AIRWAYS INC
CHANNEL ISLANDS AVIATION INC
AIR SUNSHINE INC
AVIATION CHARTERS INC
CAMDEN AVIATION INC
RUGBY AVIATION LLC
LEGACY AVIATION LLC
HUGHES FLYING SERVICE INC
BOHLKE INTERNATIONAL AIRWAYS INC
AERO NATIONAL INC
LR SERVICES INC
SOLID EDGE AVIATION L L C
EXECUTIVE AVIATION CORPORATION
CHARTER JET TRANSPORT INC
EXECUTIVE AVIATION SERVICES MANAGEMENT LLC
STEBBINS AVIATION INC
EXECUTIVE EXPRESS AVIATION LLC
ISLAND AIR CHARTERS INC
AMERICAN JETS INC
J AND M ALASKA AIR TOURS INC
AMERICAN MEDFLIGHT INC
TRAIL RIDGE AIR INC
MEMLEY AVIATION INC
TRUE AVIATION CHARTER SERVICE LLC
COBB AVIATION SERVICES INCORPORATED
AERO-TECH SERVICES INC
MERIDIAN AIR GROUP INC
WEST AIR HOLDINGS INC
FEJES GUIDE SERVICE LTD
WHITE CLOUD CHARTER LLC
MID SOUTH JETS INC
AIR CHARTER EXPRESS INC
CAPITAL CITY JET CENTER INC
HEARTLAND AVIATION INC
MIDWEST CORPORATE AVIATION INC
AVIATION CONCEPTS INC
A-OK JETS
HIGH ADVENTURE AIR CHARTER GUIDES AND OUTFITTERS I
MINUTEMAN AVIATION INC
RUSTON AVIATION INC
MOSER AVIATION LLC
CTP AVIATION LLC
MOUNTAIN AIR SERVICES LLC
SAWTOOTH FLYING SERVICE INC
COPPER VALLEY AIR SERVICE LLC
SCOTT AIR LLC
MULTI-AERO INC
SENECA FLIGHT OPERATIONS
FL AIR CORPORATION
ILLINOIS DEPT OF TRANSPORTATION-DIV OF AERONAUTICS
FLYING A FLIGHT SERVICE INC
B 2 W CORPORATION
AIRCRAFT MANAGEMENT GROUP INC
INTEGRATED FLIGHT RESOURCES INC
BUSINESS AIR INC
INTERSTATE AVIATION INC
GERLACH AND ASSOCIATES LLC
STAHELI, LEE
NORTHWESTERN AVIATION SERVICES INC
STEWART, DARYL G

JET CHARTER INC
ST CHARLES FLYING SERVICE INC
JET CONNECTIONS CORPORATION
STEELMAN AVIATION INC
ALASKA ISLAND AIR INC
STOUT FLYING SERVICE INC
JET PROS LLC
EMS AIR SERVICE OF NEW YORK INC
JETSET AIRLINES LLC
TACONITE AVIATION INC
JONES, ROBERT D JR
EUGENE FLIGHT CENTER LLC
COBALT JETS LLC
TOWER AVIATION MANAGEMENT LLC
ALBERTS AIR ALASKA LLC
TREND AVIATION LLC
KAMM, CLIFFORD S
AIR TRAVEL MANAGEMENT LLC
ALEXANDRIA AVIATION INC
UNITED STATES AVIATION CO
COLORADO FLIGHT CENTER INC
VAN AIR INC
KINGFISHER AIR INC
EXECUTIVE FLIGHT SOLUTIONS LLC
KLM AVIATION INC
EXECUTIVE HELIJET CHARTERS LLC
BUSINESS JET MANAGERS INC
WATSONVILLE EXECUTIVE CHARTER
LA MER AVIATION LLC
WEST ISLE AIR INC
LAMAR AIR LLC
WESTERN EDGE AVIATION LLC
LANMAR MARINE AND AVIATION INC
WINGS AIR CHARTER LLC
LEADING EDGE AVIATION INC
BISMARCK AIR MEDICAL LLC
LECHNER, BURDETTE J
PANORAMA FLIGHT SERVICE INC
CONTINENTAL JET CHARTER LLP
DATEMA, STEVEN K
LEGENDS LLC
DAVIS AVIATION INC
COOK INLET AVIATION LLC
ASTRO STAR AVIATION INC
LIMA NY CORPORATION
PHELPS COLLINS AVIATION INC
LOYD'S AVIATION
ATKIN, WILLARD KENT AND NIKI
AIR AMERICA FLIGHT SERVICES INC
PLANESMART! CHARTER LLC
LUXAIR LLC
ATLANTIC AIR CARGO INC
A C AVIATION SERVICES L L C
PRECISION AEROMEDICAL TRANSPORT LLC
M AND M AVIATION SERVICES LTD
PRECISION PLUS INC
BUTLER AIRCRAFT COMPANY
ATLANTIC AVIATION LEASING LLC
AIR GATO ENTERPRISES INC
AURORA AVIATION INC
MANSELL AVIATION INC
PRO AIRWAYS LLC
MARCARE AVIATION L L C
DESERT AIR AMBULANCE INC
MAYAAIR LLC
PUERTO RICO AIRCRAFT LEASING CORPORATION
AMERICAN VALET AIR INC
QUICKSILVER AIR INC
AMERICAN WINDS INC
DIRECT JET CHARTER LLC
ADVANTAGE AVIATION CHARTER LLC
RD AIR SERVICES LLC
AIR MARGARITA
READING AIR CHARTER LLC
MEEKER AIRPORT INC
AVERA MCKENNAN
CORPORATE JET LLC
RELIANT AVIATION INC
MERCY FLIGHTS INC
RENO FLIGHT SERVICES INC
CORTEZ FLYING SERVICE INC
AERO INDUSTRIES INC
COSTA, JOSEPH
DORATO JETS LLC
MIAMI CITY FLIGHT
RITE FLITE AVIATION LTD
MIAMI SEAPLANE TOURS INC
AVIATION ON DEMAND LLC
MIDWEST AIR TAXI LLC
SANDPOINT SEAPLANE SERVICES INC
MIDWEST JET MANAGEMENT LLC
SAVAGE FLYING SERVICE INC
MILLENNIUM AVIATION INC
AVIATION SPECIALISTS INC
MILLER, MARK
SHADOW AVIATION INC
MILLS BROTHERS AVIATION
SHOEMAKER, TAJ
CRAIG AIR INC
SILVER SAGE AVIATION LLC
MONARCH AIR GROUP LLC
EASTERN AIR EXPRESS INC
CREW AVIATION LLC
SKY TREKKING ALASKA LLC
MONTERY PACIFIC EXECUTIVE CHARTER LLC

SUNLIGHT AVIATION LLC
NEW ENGLAND AIR TRANSPORT INC
SUNSPLASH AVIATION LLC
ARCTIC CIRCLE AIR SERVICE INC
AIR STAT INC
FLAGSHIP PRIVATE AIR LLC
SYSTEC 2000 INC
HINSON CORPORATE FLIGHT SERVICES INC
LAKE COUNTRY AIR SERVICE LLC
HMC INTERESTS LLC
BARRIER ISLAND AVIATION LTD
NEW YORK JET INC
TECH FLIGHT AVIATION LLC
HOLLIDAY AIR INC
LANDMARK AVIATION WAUKEGAN LLC
NEXJET CORPORATION
BASEOPS INTERNATIONAL INC
CROWN AVIATION INC
EXEC AIR INC OF NAPLES
NICHOLSON, LARRY D
AIR TRANSIT SOLUTIONS LLC
NOBLE ADVERTISING INC
CHARTER FLIGHT INC
NOBLE AVIATION LLC
CATAMOUNT AIR TRANSPORT LLC
BULLOCK CHARTER INC
LEA CHARTER LLC
NORDIC AIR LLC
TRANSMOUNTAIN AVIATION INC
HOME TONIGHT AVIATION LLC
BD AEROWORKS LTD
HONEY B LLC
AIR TRANSPORT OF THE CAROLINAS LLC
NORTH FLIGHT INC
TRI-LAKES AVIATION LLC
HOPI COPTERS INC
AIRCAL INC
NORTH STAR AERO SERVICES IN
BRASWELL, JERROLD W
NORTH STAR AVIATION INC
GOLDEN WEST AIRLINES INC
HORIZON AVIATION OF VIRGINIA INC
EXECUTIVE AVIATION LLC
CIRRUS EXPLORATION COMPANY
UNIVERSAL AVIATORS ACADEMY INC
BOOMERANG L L C
VALKENBURG, PATRICK
NORTHERN AIR TRANSPORT INC
AERO-SMITH INC
ACADIAN SEAPLANES LLC
LIVINGSTON AVIATION INC
CITATION ASSOCIATES INC
LONG BAY AVIATION LLC
NORTHSTAR AERO LLC
VENTURE NORTH AVIATION LLC
AIR DIRECT AIRWAYS
VIKING AIR LLC
FRIENDSHIP FLYING SERVICE INC
W W TICHENOR AND COMPANY INC
HUNT, DONALD D
EXPEDITION HELICOPTERS INC
HUSKER AIRCRAFT REPAIR INC
WAY TO GO AERO INC
NORTON AVIATION LLC
WELLS AIRCRAFT INC
OAK AIR LTD
WEST ENGINEERING GROUP LLC
OAK RIDGE AVIATION
WESTERN AIR EXPRESS INC
OBIE, EDGAR L
CHECKER AIR LLC
OCEANAIRE INC
F S AIR SERVICE INC
HUSKEY AIR SERVICES LLC
WILDLIFE AIR LLC
ODYSSEY AIRWAYS LLC
FAIR AIR LLC
OGELSBY, WILLIAM P III
M2 AIRCRAFT MANAGEMENT LLC
OIA AIR CORP
FLORIDA AERO CHARTER INC
AIR Z FLYING SERVICE INC
MAC'S SEAPLANE SERVICE
ACTUS AVIATION L L C
MAD RIVER AIR LLC
ON EAGLES WINGS I LLC
MADERA JET CENTER INC
ZEPP AIR INC
AVIATION EXPEDITIONS LLC
ICE AGE LLC
26 NORTH AVIATION INC
IDITAROD AIR LLC
S2ONE AIR LLC
ORANGE COUNTY SUNBIRD AVIATION
SAFARI AVIATION INC
ORCHARD BEACH AVIATION INC
JOHNSTON, THOMAS
ORCHID ISLAND AVIATION INC
SAN ANGELO FLYING ENTERPRISE LLC
OREGON SUNSTONE AVIATION LLC
FALWELL AVIATION INC
AIRRESOURCE CHARTER LLC
JORGENSON, KENDRA ANNE
ACCENT AIRWAYS LLC
JOUPPI, KENNETH J

FLIGHT ALASKA INC
TANGO AIR INC
ISLAND AIRLINES LLC
RICHMOR AVIATION INC
CRITICAL CARE MEDFLIGHT INC
GTA AIR INC
ANDREW AIRWAYS INC
PLANEMASTERS LTD
ARROW WEST AVIATION
FLIGHTGEST AVIATION LLC
ILIAMNA AIR TAXI INC
PONDEROSA AVIATION INC
PAK WEST AIRLINES INC
AVCENTER INC
ABERDEEN FLYING SERVICE INC
PINNACLE AIR CHARTER L L C
ERICKSON TRANSPORT INC
G C AVIATION INC
40 MILE AIR LTD
NORTHERN ILLINOIS FLIGHT CENTER INC
SPUR AVIATION SERVICES LC
PARADIGM JET MANAGEMENT
STAR MARIANAS AIR INC
AMERICAN JET CHARTER INC
TAVAERO JET CHARTER CORPORATION
REDDING AERO ENTERPRISES INC
METROPOLITAN AVIATION LLC
AVIATION SERVICES LTD
CASTLE AVIATION INC
STERLING AVIATION LLC
JET AIR INC
JET LOGISTICS INC
ALASKA WEST AIR INC
ALASKA SKYWAYS INC
PENTASTAR AVIATION CHARTER INC
MAINE AVIATION AIRCRAFT CHARTER L L C
PM AIR LLC
TAUGHANNOCK AVIATION CORP
WARD AIR INC
KALININ AVIATION LLC
PRAIRIE AVIATION INC
STARFLITE MANAGEMENT GROUP INC
PRO AIRE CARGO AND CONSULTING INC
CLASSIC AVIATION SERVICES LLC
BRANCH RIVER AIR SERVICE INC
DESERT JET LLC
LYDDON AERO CENTER INC
VIEQUES AIR LINK INC
SCOTT AVIATION LLC
LYON AVIATION INC
NORTH COUNTRY AVIATION INC
NORTHEASTERN AVIATION CORP
MILLER AVIATION LLC
JET ACCESS AVIATION LLC
IMAGINE AIR JET SERVICES LLC
RED WING AERO PLANE COMPANY
JET METHODS INC
OMNI AIR TRANSPORT LLC
AIR SERVICES INC
PRIVATE JETS INC
KATMAI AIR L L C
AERO JET SERVICES L L C
BIGHORN AIRWAYS INC
AIR RUTTER INTERNATIONAL
KOLOB CANYONS AIR SERVICES L L C
CENTURION FLIGHT SERVICES INC
EXECUTIVE AIR SERVICES LLC
CUTTER FLIGHT MANAGEMENT INC
MCCALL AVIATION INC
PROFESSIONAL FLIGHT TRANSPORT INC
MCNEELY CHARTER SERVICE INC
GULF ATLANTIC AIRWAYS INC
DREAMLINE AVIATION LLC
AIRPAC AIRLINES INC
MOKULELE FLIGHT SERVICE INC
THE FLIGHTSTAR CORP
AMERICAN AVIATION INC
AIRCRAFT CHARTER SERVICES INC
AVIATION CONSULTANTS INC
VOYAGER JET CENTER LLC
FLIGHTIME BUSINESS JETS LLC
NORTHWEST FLYERS INC
CENTRAL AMERICAN AIR TAXI INC
TRAVELAIRE SERVICE INC
KMR AVIATION INC
SUN AIR JETS LLC
MENAGERIE ENTERPRISES INC
DOMINION AVIATION SERVICES INC
LIBERTY JET MANAGEMENT CORPORATION
TRANSPORTATION SYSTEMS INC
BASIN AVIATION INC
VENTURE TRAVEL LLC
EXECUTIVE FLITEWAYS INC
PEGASUS ELITE AVIATION INC
CAPITAL CITY AIR CARRIER INC
BUSINESS JET SERVICES LTD
FLIGHT STANDARDS DIVISION-AFS FLIGHT PROGRAM
COCKRELL RESOURCES INC
ELLIOTT AVIATION FLIGHT SERVICES INC
ANDREW BETTIS AVIATION LLC
CHICAGO JET GROUP LLC
THUNDERBIRD AIRWAYS INC
SHORELINE AVIATION INC
INTER-STATE AVIATION INC
SKY WAY ENTERPRISES INC
ULTIMATE JETCHARTERS LLC
ARROWHEAD OUTFITTERS LLC
STRATEGIC MOVES LLC
OWYHEE AIR RESEARCH INC
DECREEFT, JOSEPH M
COYOTE AIR LLC
TATONDUK OUTFITTERS LTD
ASI CHARTER INC
TIKCHIK NARROWS LODGE INC
GOLDEN EAGLE OUTFITTERS LLC
TRADEWIND CHARTER LLC
GOLDEN STATE AIR CHARTER LLC
DELAWARE AVIATION LLC
AIRFLAIR INC
TROPIC AIR CHARTERS INC
PHI AIR MEDICAL LLC
TULIP CITY AIR SERVICE INC
AIRGATE AVIATION INC
JETEX LLC
BYERLY AVIATION INC
VISION AIRLINES INC
PREMIER JETS INC
WATERS AERO MARINE INC
AUSTIN AVIATION INC
WEST BEND AIR INC
PROJET AVIATION LLC
ALASKA WILDERNESS OUTFITTING COMPANY L L C
GREAT RIVER AVIATION LLC
DUNCAN AVIATION INC
GREAT WESTERN AIR LLC
M AND N EQUIPMENT LLC
TIFFIN AIRE INC
AZTEC WORLDWIDE AIRLINES INC
WESTERN AVIATORS INC
HANGAR ACQUISITION CORPORATION
LIFEGUARD AEROMED INC
MISTY FJORDS AIR AND OUTFITTING LLC
MCMAHAN, HARLEY B
MONTANA AIRCRAFT INC
SEVEN STARS AIR CARGO
HANGAR TWELVE LLC
AIRDIALOG LLC
DIAMOND AVIATION
SURF AIRLINES, INC.
MOUNTAIN AIR SPRAY COMPANY INC
MAXAIR CHARTER INC
AIR RELDAN INC
MEEKIN, MICHAEL
CAUSEY AVIATION SERVICE INC
FLORIDA JET SERVICE INC
ABILENE AERO INC
SIERRA AVIATION INC
NAPLES AIR INC
FRESH WATER ADVENTURES INC
HILL AIRCRAFT AND LEASING CORP
BACKCOUNTRY AVIATION INC
BOUTIQUE AIR INC
LITZEN GUIDE SERVICE INC
NORTHERN AIR INC
LUFTLADDER INC
NORTHERN SKIES AVIATION INC
GOLD STAR AVIATION INC
HOMER AIR INC
GRAN AIRE INC
ARNOLD AVIATION AND THUNDER MOUNTAIN EXPRESS INC
USAIRPORTS AIR CHARTERS
COLORADO BY AIR LLC
CHRYSLER, JAMES W
HORTMONT AVIATION SERVICES INC
WINDY CITY CHARTER INC
AIROPTIONS AVIATION LLC
KING AIR INC
ONFLIGHT INC
SHIELDS AIR TRANSPORT INC
ORION AVIATION SOLUTIONS LLC
SKY AVIATION CORPORATION
COMMONWEALTH AVIATION SERVICE INC
ABOVE ALASKA AVIATION LLC
PACIFIC AIR CHARTERS INC
BUTLER AVIATION INC
HUGHES, MICHAEL F
GB AIRLINK INC
PACIFIC MISSIONARY AVIATION
BOSTON AIR CHARTER COMPANY LLC
ASI AIR CHARTER INC
SUNBIRD AVIATION INC
PACIFIC WINGS LLC
AERO TAXI INC
AIRQUEST AVIATION LP
TALKEETNA AERO SERVICES INC
IHC HEALTH SERVICES INC
WORLDWIDE AIRCRAFT SERVICES INC
PARAGON FLIGHT CHARTER LLC
TIME SAVER AVIATION LLC
CESSNA AIRCRAFT CO
BAY AIR CHARTER INC
CORDOVA AIR SERVICE INC
DAE AVIATION ENTERPRISES CORP
PCJ AVIATION LLC
MCCARTHY AIR LLC
PDQ AIR LLC
MED FLIGHT AIR AMBULANCE INC
INFLIGHT CORPORATION
VEE NEAL AVIATION INC
PHYSICIANS AIR TRANSPORT LLC
GRANDE AVIATION LLC
CORPORATE AIR CHARTERS INC
SKYS THE LIMIT INC
MONTICELLO AVIATION INC
SOIN INTERNATIONAL
MORCOM AVIATION SERVICES INC
SOUTH SIDE CORPORATION
MOREY AIRPLANE CO INC
SPEED AVIATION INC
BONNEVILLE AIRCRAFT SERVICES
SPRINGFIELD AIRCRAFT CHARTER AND SALES INC
MOUNTAIN AIR LLC
STANLEY, BARRY L
CRITICAL AIR RESPONSE ENTERPRISES LLC
STARJET INC
MT HAYES AIR
STEIN'S AIRCRAFT SERVICES LLC
MTE AIR VENTURES INC
EMERALD AIR SERVICE INC
MUNICH, HANS W
BAKER AIR LLC
N724DB LLC
BAKER AVIATION LLC
NEALCO AIR CHARTER SERVICES INC
SUNWEST AVIATION INC
NEPTUNE AVIATION SERVICES INC
T D M INC
ARCTIC BACKCOUNTRY FLYING SERVICE LLC
AERO WAYS INC
NEW ULM FLIGHT SERVICE INC
TAYLOR AVIATION INC
NEW VECTORS AVIATION INC
TISMA INC
AERIAL PHOTOGRAPHY AND SURVEILLANCE CO INC
TOM WOOD AVIATION INC
NEWTON, DONALD H
BAUM, JAMES L
NORD AVIATION INC
EXECUTIVE AIR CHARTER LLC
NORTH AMERICAN AIR CHARTER INC
BEAR MOUNTAIN AIR LLC
NORTH CENTRAL AVIATION LLC
EXECUTIVE AIR EXPRESS INC
NORTH SHORE AVIATION INC
EXECUTIVE AIRLINK INC
NORTHAIR INC
BELUGA AIR LLC
NORTHEAST MONTANA STAT AIR AMBULANCE COOPERATIVE
EXECUTIVE FLIGHT MANAGEMENT
NORTHERN WINGS AVIATION LLC
VALLEY AIRWAYS INC
NORTHSTAR BUSINESS AVIATION LLC
VANARSDALE AIR SERVICE LLC
CANDACE A LARNED ENTERPRISES INC
VANDEVENTER, MATTHEW S
CAPE CLEAR LLC
VENT AIRLINES INC
NORTHWOODS AVIATION
VERTIGO LLC
O'CONNOR, DALLAS
EXECUTIVE TRAVEL AIR L L C
OKLAHOMA AVIATION LLC
EXPRESS AVIATION SERVICES INC
CUSTOM AIR CHARTER INC
WEBSTER, JAMES M
FALLON AIRMOTIVE
EXPRESS FLIGHT INC
OPTIMAL AVIATION SERVICES LLC
BIG ISLAND AIR INC
ASHER AIR LLC
WESTERN AVIATION MANAGEMENT INC
OSPREY AIR INC
WESTERN STATES AIRCRAFT LLC
YUKON AIR SERVICE INC
WINDSTAR AVIATION INC
OVER UNDER AVIATION CORPORATION
WINGTIP CORPORATION
D AND D AVIATION INC
BIRCHWOOD AIR TAXI LLC
P AND N CORP
XPRESS AIR INC
AIR NEW ENGLAND LLC
YELLOWSTONE AIR SERVICE INC
TRANSCONTINENTAL AIRWAYS CORPORATION
SKYWAGON CORPORATION INC
DYNAMIC AVIATION GROUP INC
AMERICAN CARE AVIATION INC
AIR SOUTHEAST INC
MAINE AVIATION MANAGEMENT INC
WALKER, L WAYNE
MAINE SCENIC AIRWAYS INC
SELECT FLIGHT LLC
BRESSON FLYING SERVICE INC
E-LITE AVIATION INC
FLORIDA WINGS
T-BIRD AVIATION INC
MARCECO LTD
LIBBY PINNACLE AIR
MARCO AVIATION INC
WINDAIRWEST LLC
MARINA AIR INC
SATURN AVIATION LLC
MARJET INC
ALEUTIAN SPECIALTY AVIATION INC
MARTIN, KEVIN P. AND CHRISTINE
EGLI AIR HAUL INC
ADVANCED AIRWAYS INC
COLUMBIA FLYERS LLC
AIR DIRECT LLC
SATURN AVIATION INC
OSPREY AVIATION L L C
GIBSON AVIATION
OTIS AIR SERVICE INC
SAYERS, JAMES B
YECNY ENTERPRISES INC
CARTER'S SHOOTING CENTER INC
AIRVENTURES ALASKA INC
EAGLE RIVER AIR LLC
FLIGHT DEVELOPMENT LLC
SCOTTSDALE FLYERS L L C
OWNERS JET SERVICES LTD
SEA HAWK AIR INC
FULL CURL AVIATION LLC
ACCESSAIR CHARTERS AND MANAGEMENT LLC
CLASSIC JET CENTER LLC
JR HELICOPTERS LLC
PACIFIC AIR TAXI
BP AIR LLC
PACIFIC COAST JET CHARTER INC
AIR BORINQUEN
PACIFIC CREST AVIATION INC
AIR ALPHA INC
BLUE FEATHER CHARTER LLC
SHEARWATER AIR II LLC
INFORMART CORPORATION
SHENANDOAH CHARTER SERVICES INC
PACJET INC
SHU AIR CHARTER LLC
DARDEN, DONALD E
SILVER RANCH AIRPARK INC
INTER ISLAND AIRWAYS INC
AVIATOR SERVICES INC
PALM BEACH AVIATION INC
COLORADO AIRWAYS LLC
PALMER AIR LLC
AIR SANTA BARBARA INC
PALMER AIR TAXI
AERO RESOURCES INC
PANAVIA AIR TAXI LLC
SKYBIRD AVIATION INC
INTERLAKEN CAPITAL AVIATION SERVICES INC
SKYKNIGHT AIR SERVICES INC
INTERNATIONAL GROUP LLC
SKYMAX INC
PARADIGM HELICOPTERS LLC
SKYRUNNERS CORPORATION
PARADISE AIRLINES INC
SKYTHRILLS LLC
PARAGON AIR INC
SKYWAY AIR TAXI INC
INTERNATIONAL JET AVIATION INC
EATON, GLEN
PARIS AIR CHARTER INC
SMITH, DAVID C
PATHFINDER AVIATION INC
SMITH, TIMOTHY E
DAVES AIRCRAFT INC
SMOKY MOUNTAIN AIR CHARTER SERVICE
DAVIDSON AVIATION LLC
EDS FLYING SERVICE INC
BUSH AIR CARGO INC
SNOWSHOE AIR LLC
G AND S AVIATION
AIREXCELLENCE LLC
PECOS AIRCRAFT SALES AND LEASING LLC
KERN CHARTER SERVICE INC
ISLA NENA AIR SERVICE INC
SOUND AIRCRAFT FLIGHT ENTERPRISES INC
CLOUD NINE AVIATION LLC
B & F AVIATION INC
PEORIA AVIATION LLC
SOUTH BAY LTD
PEREGRINE AIR CHARTERS LLC
SOUTHEAST AVIATION LLC
PERFECT LANDINGS INC
KESTREL AVIATION INC
ISLAND AIR TAXI LLC
SOUTHERN SKY INC
AKROYD, ROBERT F JR
SOVEREIGN AIR LLC
DAVONAIR INC
ALPHA AIR TRANSPORT LLC
ATD FLIGHT SYSTEMS LLC
ELITE AVIATION LLC
A G SHOLTON COMPANY
SPIRIT MOUNTAIN AVIATION L C
G F AIR L L C
SPRAY, CARL
PILOT SERVICES CORP
KEY WEST EXECUTIVE AIR CHARTER LLC
PILOTS CHOICE AVIATION INC
4 W AIR LLC
CLOUD PEAK AVIATION LLC
AIR SITKA INC
DC3 FLYING CIRCUS LLLP
CHARTER FLEET INTERNATIONAL LLC
CAREFLITE
STARK AIRWAYS LLC
CARIBBEAN BLUE AIRWAYS CORPORATION
ELLISON AIR INC
PLANE TRAVEL LLC
KISS AVIATION LLC
JAARS INC
GLOBAL FEEDER SERVICES LLC

ULTIMATE JETCHARTERS LLC
SOUTHERN SEAPLANE INC
AVIATION CHARTER INC
SOUTHWEST AIRCRAFT CHARTER L C
WEATHER MODIFICATION INC
BURGESS AIRCRAFT MANAGEMENT LLC
HOUSTON AIR INC
EXEC AIR MONTANA INC
MAJESTIC JET INC
CORPORATE AIR TRAVEL LLC
JOURNEY AVIATION LLC
PRIME JETS LLC
PRESIDENTIAL AVIATION INC
MIDWEST AVIATION DIV OF SOUTHWEST A
CONYAN AVIATION INC
ELDORADO AIR LLC
FLY 4 YOU INC
MIDWEST FLYING SERVICE INC
COURTNEY AVIATION INC
WORLD WIDE JET CHARTER INC
M AND N AVIATION INC
GLOBAL AVIATION INC
TALKEETNA AIR TAXI INC
RELIANT AIR CHARTER INC
ACP JET CHARTERS INC
REVA INC
TRANS-EXEC AIR SERVICE INC
RICHLAND AVIATION INC
TRI STATE AERO INC
MODESTO EXECUTIVE AIR CHARTER INC
METRO AVIATION INC
CHANTILLY AIR INC
AIR TREK INC
BAER AIR INC
IFL GROUP INC
LYNCH FLYING SERVICE INC
FALCON EXECUTIVE AVIATION INC
SEVEN BAR FLYING SERVICE INC
AITHERAS AVIATION GROUP LLC
DEER HORN AVIATION LTD COMPANY
BLATTI AVIATION INC
SILVERHAWK AVIATION INC
O'HARA FLYING SERVICE II LP
CIN-AIR LP
MAXIMUM FLIGHT ADVANTAGES LLC
SKY QUEST LLC
TRANS EXECUTIVE AIRLINES OF HAWAII
ADVANCED AIR MANAGEMENT INC
KAISERAIR INC
SOURDOUGH AIR SERVICE INC
BATON ROUGE AIR CHARTER AND MANAGEMENT
CARVER AERO INC
TULSAIR BEECHCRAFT INC
NEW ENGLAND AIRLINES INC
EXEC1 AVIATION
EPPS AIR SERVICE INC
AMERICAN JET INTERNATIONAL CORPORATION
ATI JET INC
ISLAND BIRD INC
DUPAGE AEROSPACE CORPORATION
MIDWEST AERO CLUB LLC
DOLPHIN ATLANTIC INC
SUBURBAN AIR EXPRESS INC
GALLUP FLYING SERVICE INC
DAEDALUS INC
GALVIN FLYING SERVICES INC
GARY JET CENTER INC
CAL-ORE LIFE FLIGHT LLC
BUN AIR CORPORATION
SAFFORD AVIATION SERVICE INC
AVIATION SERVICES GROUP INC
MALONE AIRCHARTER INC
AMERICAN AIR CHARTER INC
FLYCAROLINA LLC
REDEMPTION INC
AVION JET CHARTER LLC
BAM DENTON MANAGEMENT VENTURES LLC
MAVERICK AIRLINES INC
AIR 1ST AVIATION COMPANIES OF OKLAHOMA INC
SLICKROCK AIR GUIDES INC
WRANGELL MOUNTAIN AIR INC
ORION AVIATION L L C
TRANSNORTHERN LLC
AIRMED INTERNATIONAL LLC
RENO FLYING SERVICE INC
PACIFIC AIRWAYS INC
VALLEY MED FLIGHT INC
PACIFIC WINGS L L C
CHARTER AIR TRANSPORT INC
BARBER, JACK B
SC AVIATION INC
AIRBORNE FLYING SERVICE INC
NORTH DALLAS AVIATION INC
KANSAS CITY AVIATION CENTER INC
EAST COAST JETS INC
AIR MD LLC
SHORT HILLS AVIATION SERVICES INC
MCPHILLIPS FLYING SERVICE INC
LATITUDE 33 AVIATION LLC
MEDWAY AIR AMBULANCE INC
BALD MOUNTAIN AIR SERVICE INC
CORPORATE AIR CHARTERS INC
AIR ASSOCIATES CHARTER INC
PIONEER BUSINESS SERVICES LLC
WHEELS UP CHARTERS LLC
PIRATE AIRWORKS INC
DESERT AIR TRANSPORT INC
ATKINS, RAY
SEDONA SKY TREKS INC
PORTERVILLE AVIATION INC
SERVANT AIR INC
PRECISION AVIATION INC
SHADE, ERIC LOREN
AIR HAMPTONS
FLY DENALI INC
AIR 7 LLC
SKINNER AVIATION INC
ATLANTIC JET LLC
SKY CASTLE AVIATION LLC
AUGUSTA AVIATION INC
SMOKEY BAY AIR INC
EXECUTIVE AIR TRANSPORT INC
ALS AIR SERVICE
PROFLITE LLC
FRONTIER FLYING SERVICE INC
CORPORATE FLIGHT INTERNATIONAL INC
CHERRY-AIR INC
ABOVE IT ALL INC
LANE AVIATION CORP
JACKSON AIR CHARTER INC
STANTON, THOMAS MICHAEL
QUALITY AVIATION INC
GEORGIA FLIGHT OF DE INC
JEFFERSON CITY AVIATION INC
ADVANCED AIR LLC
R AND M AVIATION INC
SUN AVIATION INC
RAI JETS LLC
GLASER, DONALD E
RAINBOW INTERNATIONAL AIRLINES INC
SUNRISE AVIATION
RAPID AIR II LLC
GLOBAL AIR CHARTERS INC
AVERITT AIR INC
SWIFT AIRCRAFT MANAGEMENT LLC
BLUE SKY ENTERPRISES LLC
TALON AIR SERVICE INC
REGENCY AIR L L C
THE BERKELEY GROUP LLC
AIR WEST INC
THUNDERBIRD AVIATION INC
CHARLESTON FLIGHT MANAGEMENT LLC
WRIGHT AERO INC
RHINELANDER FLYING SERVICE INC
CUSTOM JET CHARTERS LLC
A B FLIGHT SERVICES INC
MAUI ISLAND AIR INC
FAA WASHINGTON FLIGHT PROGRAM
BAY AIR INC
RICO AVIATION LLC
BYGONE AVIATION LLC
CRITICAL AIR MEDICINE INC
TROPIC OCEAN AIRWAYS
RIVER RUN AIR CHARTER LLC
TUCKER AVIATION INC
ROGERS HELICOPTERS INC
TUNDRA LTD
ADEX-ASG LLC
ULTIMA THULE AIR LLC
RSVP JET INC
USA JET AIRLINES INC
JPS AVIATION LLC
VANDERPOOL, ROBERT W SR
BUSINESS AVIATORS INC
VENTURE JETS INC
CROW EXECUTIVE AIR INC
DAVISAIR INC
FJORD FLYING SERVICE LLC
BETTLES AIR SERVICE
CRYSTAL AERO GROUP INC
GRANT, RODERICK M
FLIGHT SAFETY ALASKA INC
MIDAMERICA JET INC
SCENIC MOUNTAIN AIR INC
CATALINA AEROSPACE CORPORATION
FLIGHTLINE FIRST LLC
MIDLAND AIRCRAFT SALES AND SERVICE INC
SCHUSTER, JOE S
CATALINA FLYING BOATS INC
FLORIDA AIR CARGO INC
SCOTT RICHARD AVIATION SERVICES INC
YUTE AIR TAXI INC
MACAIR INC
MCCREERY AVIATION CO INC
TRIAD AIR CHARTER LLC
RESORT AIR LLC
DEGOL AVIATION INC
FARE SHARE LTD
SPENCE, JOSEPH H
FELTS FIELD AVIATION INC
WIEDERKEHR AIR INC
FINKBEINER, CHRIS
COLUMBIA FLYERS LLC
MASDEN, MICHELLE
KUGEL TRAVEL AND TRANSPORTATION SERVICES LTD
MASON COUNTY AVIATION INC
AIR TAXI INCORPORATED
AIR GRAND CANYON INC
TRITON AIR CORPORATION
ADVANCED FLIGHT SOLUTIONS LLC
VECTOR-USA LLC
AIR JUNEAU INC
GRANDAIR AVIATION INC
FLY ARKANSAS LLC
BIRCHWOOD AIRCRAFT SERVICES LLC
AIR MADURA LLC
AVIATION PARTNERS OF BOYNTON BEACH LLC
FLY GFORCE LLC
AVIATION SERVICES GROUP LLC
MCCLELLAND AVIATION COMPANY INC
KALEIDOSCOPE CHARTER SERVICES CORP
MCCRARY, MICHAEL P
SKYJET ELITE INC
AH AERO SERVICES LLC
EDS FLIGHT COMPANY INC
C AND C AVIATION INC
KERR, WILLIAM J AND KILMER, ROBERT
GRETZKE, ROBERT C
SPRING CITY AVIATION INC
AIRCHARTERS WORLDWIDE INC
STERLING AIR SERVICE
MCRAE AVIATION SERVICES INC
KRYSTAL AVIATION LLC
MCZ MANAGEMENT INC
AIR CENTER HELICOPTERS INC
CHAPLINAK AIR LLC
THE BUSH PILOT INC
ADVANTAGE FLIGHT SOLUTIONS LLC
LATITUDE ENTERPRISES INC
GULF AIR LLC
TRAX AIR CHARTER LLC
ACTION AIR CHARTER LLC
TUCSON AEROSERVICE CENTER INC
CORPORATE WINGS LLC
GOODLAND REGIONAL MEDICAL CENTER
AMERITEX AIRWAYS INC
LOWE AVIATION CO INC
MERCHANT, CLIFFORD ROBERT
LUMANAIR INC
MERCURY AIR CARGO INC
AMERICAN BUSINESS AIRWAYS INC
GULF AVIATION INC
WINGS OVER KAUAI LLC
FLYING M AVIATION INC
Y2K AVIATION LLC
GULF COAST AVIATION CHARTER LLC
SAFEWING AVIATION INC
COUPCHIAK AVIATION INC
EAGLE AIR INC
METROJETS LLC
SCANLON AVIATION LLC
ACTION AIR EXPRESS INC
SEA TO SKY AIR INC
HANGAR 10 INC
JS VENTURES LLC
MIAMI-GO AIR, LLC
GILBERT AVIATION LLC
MICRONESIAN AVIATION CORPORATION
SKY NIGHT L L C
AIKEN AIR SERVICES LLC
SKYNET LLC
MIDAMERICA CHARTERS LTD
KENOSHA AERO INC
COVE PARTNERS LLC
SNOW GOOSE AIRWAYS LLC
MID-COAST AIR CHARTER INC
SOUND AVIATION LLC
COVENANT FLIGHT GROUP
B AND G FLYING SERVICE INC
ADVENTURE AIR LLC
SPHERE ONE INC
MID-OHIO AVIATION INC
KINERT AVIATION INC
ADVENTURE AIRWAYS INC
KIRST, FOREST
HANGAR 9 INC
STEWART, MIKE F
ANTHEM COMMERCIAL AIR SERVICES INC
KRAMER AVIATION INC
MIDWEST AVIATION SERVICES INC
SUNRISE AIRLINES INC
COWBOY AVIATION SERVICES LP
SWIFT RIVER AIR LLC
MIDWEST JET CHARTER INC
LAKESHORE AVIATION LLC
FORGEY, CARL R
TELECOM AIR INC
HANSON, SHIRLEY A
BASLER TURBO CONVERSIONS LLC
MILLER, DENNIS C
LANIER FLIGHT EXPRESS LLC
FOSS AND MEIER INC
TRANS CARIBBEAN AIR EXPORT IMPORT INC
GLOBAL FEEDER SERVICES LLC
ACE PILOT TRAINING INC
STERLING ELITE AIR SERVICES INC
PLATINUM AIR SERVICE INC
COMMERCIAL AVIATION ENTERPRISES INC
ATLANTA AIR CHARTER INC
EMERY AIR INC
POINT-TO-POINT AVIATION INC
STRANG, JAMES W
JACKS AIR SERVICE INC
STYLE AVIATION SERVICES INC
POLARIS AVIATION SOLUTIONS LLC
COMMONWEALTH AVIATION LLC
POLLACK AND SONS FLYING SERVICE INC
SUMMIT AVIATION LLC
PONDEROSA AIR LLC
AERO SYSTEMS INC
AIR EXCURSIONS LLC
ENDLESS MOUNTAINS AIR INC
JACKSONVILLE AIR SERVICES INC
SUNNYFIELD AVIATION ASSOCIATES LLC
POPE, GEOFFREY M
ENTERPRISE PRODUCTS COMPANY
PORT TOWNSEND AIR LLC
SUNVIEW AIR INC
POTOMAC AIR CHARTER LLC
SUPREME AIR CARGO INC
ATLANTIC AIRLINES INC
GLOBALJET NA LLC
JACOB STERN AND SONS INC
SYLVANIA AIR TRAVEL INC
FLIGHT READY AVIATION LLC
SZABO AEROSPACE LLC
FAMILY AIR TOURS LLC
CONCORD JET SERVICE INC
PREMIER AVIATION L. L. C.
AERO-COPTERS OF ARIZONA INC
PREMIER AVIATION LLC
BARR AIR PATROL LLC
PREMIER AVIATION TRAINING AND MANAGEMENT LLC
GOLD COAST AVIATION INC
PREMIER CHARTER INC
TBP AERO INC
AIR OPS LLC
TEDS AIR SERVICE
PREMIER TRANS AIRE INC
BARRON AVIATION PRIVATE FLIGHT SERVICES LLC
JAZZ AVIATION LLC
THE BRADFORD CAMPS CORPORATION
JB AVIATION LLC
THE FLIGHT SHOP INC
COASTAL AIR LLC
AEROMEDEVAC INC
PRIOR AVIATION SERVICE INC
AIR SUPPLY ALASKA INC
CHARLIE ROMEO LLC
TIFFIN AVIATION SERVICES INC
JEM AIR HOLDINGS LLC
TIM J. KEPP LLC
GARY AIR SERVICES LLC
CONQUEST CHARTER INC
ALASKA AIR INC
TOK AIR SERVICE LLC
AVALANCHE ENTERPRISES LLC
TOM'S ALASKAN AIR LLC
PROFLIGHT AVIATION LLC
TRACKER AVIATION INC
JET AIR CHARTER LLC
AIR TRANSPORT INC
CARIS AIR SERVICES LLC
LAWSONS AVIATION SERVICES INC
AIR OZARK LLC
TRANS NORTHERN AIRWAYS LLC
ALASKA BUSH FLOATPLANE SERVICE CO
EXECUTIVE AERO CHARTER MANAGEMENT LLC
DEVINAIRE LLC
GOLDEN EAGLE ENTERPRISES INC
PUBLIC CHARTERS INC
TRANSWORLD EXPRESS LLC
PUERTO RICO AIR MANAGEMENT SERVICES INC
BEAR AVIATION AND HELICOPTER LLC
JET AIR L L C
TREASURE AIR CHARTERS LLC
JET AIRWAYS INC
CONSTRUCTION HELICOPTERS INC
CHARLOTTE CHARTER JET
LEE AERO LLC
DILLON FLYING SERVICE INC
CONTINENTAL AVIATION SERVICES CORP
R AND R AVIATION INC
TRITON AIRWAYS LLC
DIRECT FLIGHT INC
CATLIN FLYING SERVICE LLC
GATEWAY AVIATION INC
TROPICAL AVIATION CORP
JET CHARTER 365 LLC
EXECUTIVE AIRCRAFT SERVICES INC
FILKILL, DAVID B
EXECUTIVE AIRLINES COMPANY INC
RAMPART AVIATION LLC
CAVU AVIATION

SUN AIR EXPRESS LLC
NATIONAL JETS INC
KENAI AVIATION INC
HARMONY AIR LLC
BIDZY TA HOT AANA CORP
NEW WORLD AVIATION INC
ISLA GRANDE FLYING SCHOOL AND SERVICE CORPORATION
VENTURE AVIATION GROUP L L C
MIDLANTIC JET CHARTERS INC
CHARLES CITY AERONAUTICS INC
EXECUJET CHARTER SERVICE INC
CORPORATE AIRCRAFT MANAGEMENT INC
BODE AVIATION INC
SAN ANTONIO AIR CHARTER INC
CENTURY AVIATION INC
CORPORATE FLIGHT ALTERNATIVES INC
ADDISON JET MANAGEMENT INC
ARCTIC AIR ALASKA INC
PRIORITY AIR CHARTER LLC
CROTTS AIRCRAFT SERVICE INC
TEMPUS JETS INC
SECURE AIR CHARTER LLC
BAL INC
JET SOURCE CHARTER INC
THRESHOLD AIR CHARTER INC
DALE AVIATION INC
AIR AMERICA INC
ALASKA CENTRAL EXPRESS INC
JIM HANKINS AIR SERVICE INC
PATRICK, SCOTT
LEE, GERALD R
SOUTHERN JET INC
BLUE ASH CHARTERS LLC
MOYER AVIATION INC
CAMERA WORK INC
RENFROS ALASKAN ADVENTURES INC
CAPITAL JET INC
TRISTATE CAREFLIGHT LLC
CENTRAL FLYING SERVICE INC
MAXAIR INC
CHESTER CHARTER INC
NORTHROP GRUMMAN SYSTEMS CORPORATION
CHRYSLER AVIATION INC
PROPILOT INC
AIR CHARTER SERVICE INC
S P AVIATION INC
CLEARWATER AIR INC
SUNQUEST EXECUTIVE AIR CHARTER LLC
AIR EXEC INC
WESTERN MONTANA AVIATION LLC
AIR FLIGHT INC
MACH ONE AIR CHARTERS INC
CORPORATE FLIGHT INC
AMIGOS AVIATION INC
CRAIG AIR CENTER INC
NICHOLAS SERVICES LLC
AIR MED SERVICES LLC
ASHEVILLE JET CHARTER AND MANAGEMENT INC
CRYSTAL AIR INC
PIONEER AIR SERVICE LLC
CURRIERS FLYING SERVICE INC
QUEST DIAGNOSTICS INC
D AND D AVIATION L C
RSB INVESTMENTS INCORPORATED
DON DAVIS AVIATION INC
SNOHOMISH FLYING SERVICE INC
EAGLE AVIATION INC
SPERNAK AIRWAYS INC
EAST COAST FLIGHT SERVICES INC
AERONAUTICAL CHARTER INC
ELKHORN AVIATION INC
VOLO AVIATION LLC
EXECUFLIGHT INC
LEADING EDGE AVIATION SERVICES INC
EXECUTIVE AIR TAXI CORP
LIFEGUARD AIR AMBULANCE INC
EXTRAORDINAIR AVIATION AND CHARTER INC
MAINE INSTRUMENT FLIGHT
FIRST AV GROUP LLC
MEREGRASS INC
FIRST WING MANAGEMENT LLC
MIDDLE FORK AVIATION INC
AIRCRAFT SERVICES GROUP INC
NAPA JET CENTER INC
GLOBAL EXEC AVIATION
NORTHCOAST JET MANAGEMENT INC
GREAT LAKES AIR INC
NORTHWEST SEAPLANES INC
GRIFFING FLYING SERVICE INC
ASPEN HELICOPTERS INC
HARRIS AIRCRAFT SERVICES INC
PAVCO INC
HOLMAN LEASING SYSTEMS INC
PREMIER AIR CHARTER LLC
HOPSCOTCH AIR INC
PTARMIGAN AIR LLC
AIRWAY AIR CHARTER INC
REDISKE AIR INC
INTERNATIONAL JET CHARTER INC
RITE BROS AVIATION INC
ISLAND AIR INC
PROSPECT AVIATION CORP
BRAZOS VALLEY FLIGHT SERVICES LLC
SHELDON AIR SERVICE LLC
CENTRAL MISSOURI AVIATION INC
SWANSTROM, PAUL N
AIR CARRIAGE INC
VENTURA AIR SERVICES INC
ACE TRANSPORT SERVICE INC
PAYNE, JAMES R
AIRBROCK MANAGEMENT AND CHARTER SERVICES INC
PRESCOTT SUPPORT CO
FRESH AIR AVIATION
RDM PILOT-GUIDE LTD
FRESH AIR LLC
SAN DIEGO AIR SERVICE INC
AIR CHARTER EXPRESS LLC
SKYLINK JETS INC
BRISTOL BAY AIR SERVICE INC
STELLER AIR SERVICE LLC
FUGA INC
TMF AIRCRAFT INC
GALAXY AIR SERVICES FBO LLC
VALLEY AIR SERVICE
GALLATIN FLYING SERVICE INC
WELLSVILLE FLYING SERVICE INC
CHARLIE HAMMONDS FLYING SERVICE INC
PAKLOOK AIR INC
GEM AIR LLC
PETRIE, MICHAEL A
GEMINI AIR GROUP INC
PONTIAC FLIGHT SERVICE INC
GEORGES AVIATION SERVICES INC
PRIVATEFLITE AVIATION LLC
GFK FLIGHT SUPPORT INC
RAINBOW AIR CHARTER INC
GOLD AERO
REEVE AIR ALASKA LLC
CHARTER FLIGHTS CARIBBEAN
RICK AVIATION INC
BROOKS FLYERS LLC
EARTH CENTER ADVENTURES INC
GRASSHOPPER AVIATION LLC
SILVERTIP AVIATION LLC
GREAT NORTHERN AIR LLC
SOLUTIONS AIR CHARTER LLC
GREAT POINT AIR CHARTER LLC
ELLIS, WENDELL KIRK
CHERRY CAPITAL FLIGHT LLC
SUMMIT AVIATION INC
GREGG FLYING SERVICE INC
ERIN AIR INC
BROOKS SEAPLANE SERVICE INC
TRANS NORTH AVIATION LTD
AIRLINE AVIATION ACADEMY INC
TWIN CITIES AIR CHARTER INC
GULF COAST AIRWAYS INC
ACE FLIGHT CENTER
CHESAPEAKE AVIATION INC
BETTER LIVING AVIATION INC
HANTZ AIR LLC
WESTERN AIR ENTERPRISES INC
HAPS AIR SERVICE INC
WINNER AVIATION CORPORATION
HARVARD AIR TAXI LLC
PANTHER AVIATION INC
HELMS, HERBERT R
PENINSULA AIRWAYS INC
HERMISTON AVIATION INC
PIGS CAN FLY AVIATION LLC
HESSJET LLC
POLARIS AIR LLC
HIGHTAIL AIR CHARTER LLC
PRECISION LLC
HILLSBORO AVIATION INC
CARIBBEAN HELI-JETS INC
CITY WINGS INC
PROFESSIONAL AIR CHARTER INC
HUSTED AND HUSTED AIR CHARTER INC
PULVER AIR CHARTER LLC
IMAGE AIR CHARTER LLC
RAM AIR SERVICES LLC
IMAGE AIR OF SOUTHWEST FLORIDA LC A FLORIDA LLC
RECTRIX AVIATION INC
ADAMS, BRUCE M
CARROLL AVIATION INC
ISLAND WINGS INC
RICHARDS AVIATION INC
JACKO, JOSH EARL
S AND S AVIATION INC
JATO AVIATION LLC
SANTA BARBARA AVIATION INC
JAY AIR LLC
EAST SHORE AVIATION LLC
JEFFRIES, RONALD GAYLE
SIEGEL AVIATION LLC
JET 1 CHARTER INC
EASTON AVIATION LLC
ADAMS, ROBERT L
SLUICE BOX INC
COASTAL AIR TRANSPORT INC
AIR SITARAH INC
FOSTER, DAWN E
BAY LAND AVIATION INC
MILO AIR INC
FLIGHTLINE INC
MINTA INC
TROPICAL AIR FLYING SERVICES INC
BLUE BELL AIR LLC
TURNKEY JET INC
MISSION MOUNTAIN FLYING SERVICES LLC
USAC AIRWAYS 691 LLC
MISSION TRANSPORTATION LLC
VAN WAGENEN, ROBERT F
MISSISSIPPI AIR EXPRESS LLC
AEROSTAR FLIGHT SERVICES LLC
HARCO MANAGEMENT SERVICES LLC
LP AVIATION LLC
MOAIR INC
LSAC ENTERPRISES LLC
MOBILE CRANE SERVICES INC
EXPRESS CARRIERS INC
MODERN TRANSPORTATION COMPANY INC
M A A INC
AQUATICA AVIATION INC
CHEM AIR INC
FOX AIRCRAFT LLC
WING, ROBERT EVERTS
MONARCH SKY LLC
WOFFORD AVIATION INC
HARVEY, CHARLES S
XANADU AVIATION LLC
MONTANA BY AIR L L C
DX SERVICE COMPANY INC
HAWK AVIATION INC
SACO LLC
HEART OF VIRGINIA AVIATION INC
SAMTEX USA INC
AIR CHARTER NETWORK INCORPORATED
SAN JUAN JET CHARTER INC
HELICOPTER CONSULTANTS INC
SAPPHIRE AVIATION HOLDINGS LLC
MORRISTOWN FLYING SERVICE INC
SAWYER AVIATION LLC
CHOICE AIRWAYS INC
SCHUH, RODNEY J
MOSER, MIKE
SEA BREEZE AIRWAYS LLC
MOUNTAIN AIR CHARTER LLC
SEBASTIAN AERO SERVICES INC
HELIWORKS LLC
SER AVIATION LLC
MOUNTAIN AIR SERVICE LLC
COFFELT, JOHN X
FREEDOMAIR LLC
ALBATROSS AIR INC
3D AVIATION INC
CHARTER AIRLINES LLC
MOUNTAIN AVIATION ENTERPRISES LTD
KAVAN AIR LLC
MOUNTAIN HIGH AVIATION LLC
KELLER, MATTHEW CHARLES
MOUNTAIN LIFEFLIGHT INC
GLOBAL AIR SUPPORT LLC
HENDRICK MOTORSPORTS LLC
BLUE SKY CHARTER LLC
FEARHEILEY FLYING SERVICES INC
SKYWAYS LTD
MULCHATNA AIR TAXI LLC
SMITH, MICHAEL E
AIR MEDICAL CHARTERS LLC
SMS LEASING LLC
FRESH AIR CARGO LLC
SNOWY RANGE AIR LLC
HETRICK AIR SERVICES INC
SOMERSET AIR SERVICE INC
NANTUCKET EXPRESS
SOUSA, GERALD L
CROW CREEK AIR SERVICE LLC
SOUTHERN AIR SYSTEMS INC
CAM AVIATION INC
B FOUR FLYING INC
NAPLES SEAPLANE CHARTER INC
ALPHA AVIATION OF MORRISTOWN INC
NAPTOWNAIR LLC
ELITE BUSINESS AIRCRAFT LLC
NATIONAL AIR CHARTERS INC
COLUMBIA AVIATION INC
ARCTIC AIR TRANSPORT L L C
BACKCOUNTRY AIR LLC
NATRON AIR INC
STATEWIDE CONTRACT SERVICES LLC
NAVAIR INC
STELLAR AVIATION SERVICES LLC
NAVY ANNAPOLIS FLIGHT CENTER
STEVENSON, WILLIAM EDWARD
HICKS, DAVID
KOOTENAI AVIATION INC
NEITZ AVIATION INC
AERO S E A T INC
FEDERICO HELICOPTERS INC
KRUSE, JEFFERY J
BROWN-WESTERN AVIATION LLC
DISTINGUISHED FLIGHT CHARTER INC
LFS INCORPORATED
RAS AVIATION LLC
LIBBY CAMPS
RAS INC
UNIVERSAL AIRWAYS INC
RAVEN AIR LLC
UNLIMITED AVIATION INC
RB AVIATION LLC
LIBERTY AIR MANAGEMENT
RBW ENTERPRISES INC
CONTRAIL INC
FLIGHTCRAFT AVIATION SERVICES INC
VALLEY AVIATION LLC
ALASKA FLY-BY-NIGHT LLC
GORGE WINDS AVIATION INC
REACH AIR MEDICAL SERVICES LLC
COOL AIR INC
AIREAST SERVICES L L C
LOCHSA AVIATION LLC
JET NEVADA INC
LONAIRE FLYING SERVICE INC
RED EAGLE AVIATION INC
LONG ISLAND AIRLINE LLC
A L E R T KALISPELL REGIONAL HOSP
AIR VENTURES HAWAII LLC
AIRBRIDGE ENGINEERING LLC
BERKSHIRE AVIATION ENTERPRISES INC
DODSON INTERNATIONAL CORP
GQ AVIATION INC
AIR PARADISE INC
VIKING AVIATION LLC
ALASKA MOUNTAIN TRANSPORT L L C
COPPER RIVER AIR TAXI LLC
REGAL-BELOIT FLIGHT SERVICE INC
WALKABOUT AIR
DOMINION AIR CHARTER INC
WALTER AVIATION INC
AVIA AIRLINK INTERNATIONAL CORP
BEVERLY AIR TRANSPORT
ALASKA SCENIC AIR LLC
CHARTER MANAGER LLC
CARLIN, JEFF
WAYMAN AVIATION SERVICE INC
JET THERE LLC
WEISER AVIATION
JET-A LLC
LUTHER AIRCRAFT LLC
AERO CONNECTION INC
CHARTERLINES INC
COASTAL SEAPLANES SERVICE INC
AMERICAN AVIATION CHARTERS L L C
BUSH WINGS AIR SERVICE INC
AMERICAN AVIATION SERVICES INC
DORADO AVIATION LLC
BIG SKY AERIAL EXPEDITIONS INC
CHART AIR INC
EXPRESSAIR MESSENGER INC
JETSET AVIATION LLC
AIR CARE INC
JETSTREAM AVIATION INC
AGUADILLA AIRLINES SERVICES INC
DOYLE PARTNERS LLC
BRASWELL, LEON C
JIB INC
WILD BLUE AIR LLC
RIVERSIDE CHARTER LLC
WILLIAMS, JOHN N
RL AVIATION II LLC
M C AVIATION CORP
RLS RENTAL COMPANY
WING AND A PRAYER AVIATION INC
RLV INDUSTRIES INC
WINGS ACADEMY ENTERPRISES INC
RMG FLIGHT SERVICES
WINGS INC
DREAMSHORE AERO LLC
CORNERSTONE AVIATION LLC
ROSE AIR
BIOTECH AVIATION LLC
AERO JET INTERNATIONAL DE PR INC
WOMACK, BERT
ROYAL PACIFIC AIR LLC
WORLD JET II INC
ROYALE AIR SERVICE INC
FALCON AVIATION LLC
AVIATION ENTERPRISES INC
AIR WILMINGTON INC
CARTER FLYGARE INC
XCEL JET MANAGEMENT INC
RTR CORP
X-PRESS CHARTER SERVICES INC
RUE, DAVID
MAGNUSON AIRWAYS LLC
AIR ROUTING INTERNATIONAL L P
OTTUMWA FLYING SERVICE INC
YUKON HELICOPTERS INC
OUTER BANKS AIR CHARTERS INC
AIR ARCTIC INC

Part 125		
AIRBUS AMERICAS INC	ROUSH AIR LLC	CONOCOPHILLIPS AVIATION
SAAB AIRCRAFT OF AMERICA INC	MENARD INC	LAURIDSEN AVIATION MUSEUM
EVERTS AIR FUEL	JET STREAM AVIATION LLC	PEN TURBO INC
GMJ AIR SHUTTLE LLC	JOHNSON CONTROLS INC	LEARJET INC
AERO CONTRACTORS LTD	JOE GIBBS RACING	PRINCIPAL AIR SERVICES LLC
THE LIMITED BRANDS INC	REMOTE AREA MEDICAL INC	MCKINLEY AIR INC
MISSIONARY FLIGHTS INTERNATIONAL	AFM HARDWARE LLC	RCR AIR INC
MID EAST JET INC	FRESH AIR INC	C AND M AIRWAYS INC
PARADIGM AIR OPERATORS INC	GRECOAIR	ROUNDBALL LLC
TEPPER AVIATION INC	PENSKE JET INC	MIAMI AIR LEASE INC
LAS VEGAS SANDS CORPORATION	BLUE JACKETS AIR LLC	ATX AIR SERVICES LLC
SURDEX GEOSPATIAL SYSTEMS INTEGRATION LLC	FERRETERIA E IMPLEMENTOS SAN FRANCI	A-LINER-8-AVIATION INC
FLORIDA AIR TRANSPORT INC	INTERFACE OPERATIONS LLC	FLAGSHIP DETROIT FOUNDATION
CONOCOPHILLIPS ALASKA INC	FUN AIR CORP	MIRAGE AVIATION LTD
HENDRICK MOTORSPORTS LLC	JEGE INC	TAG AIR INC
BLUE RIDGE AERO SERVICE	PARALLEL EXPRESS INC	CLASSIC DESIGN INC
TOTAL LAND EXPLORATION	ADVANCE LEASING COMPANY	THE BOEING COMPANY
CHAMPION AIR LLC	PROJECT ORBIS INC	MSG FLIGHT OPERATIONS L L C
ATLANTIC COAST AIRCRAFT SERVICES INC	AA767 LLC	BERLIN AIRLIFT HISTORICAL FOUNDATION
STEWART-HAAS RACING LLC	ELAN EXPRESS INC	ARAMCO ASSOCIATED CO
THE DOW CHEMICAL COMPANY	YUCAIPA COMPANIES L L C	TRACINDA CORPORATION
FRYS ELECTRONICS INC	BASIC CAPITAL MAJESTIC	AERO SPECIALISTS INC
MWR RACING LLC	BLUE RIDGE PIEDMONT AND CHESAPEAKE AIRWAYS INC	VALLEJO INVESTMENTS INC
SAVE A CONNIE INC	FROST ADMINISTRATIVE SERVICES	OLYMPIA AVIATION L L C
NATIONAL NUCLEAR SECURITY ADMINISTRATION	KEB AIRCRAFT SALES INC	ORBITAL SCIENCES CORPORATION
BLUE CITY HOLDINGS LLC	UNITED BREWERIES HOLDINGS LTD	JETT CLIPPER JOHNNY L L C
COMCO CORPORATION	BRUNSKOLE AVIATION GROUP INC	ADI SHUTTLE GROUP LLC

Part 91		
AVIATION SECTION DRUG ENFORCEMENT ADMINISTRATION	STATE OF UTAH WILDLIFE RESOURCES	MULTNOMAH COUNTY SHERIFFS OFFICE
557TH FTS USAF	STATE OF SOUTH DAKOTA DEPARTMENT OF TRANSPORTATION	CITY OF PALM SPRINGS POLICE AERO SQUADROM
CALIFORNIA DEPT OF FORESTRY AND FIRE PROTECTION	LOS ANGELES COUNTY SHERIFFS DEPARTMENT	TRINITY RIVER AUTHORITY OF TEXAS
NASA JOHNSON SPACE CENTER	SOUTH CAROLINA DEPARTMENT OF NATURAL RESOURCES	PINAL COUNTY SHERIFF AIR UNIT
34TH OG-OGQ USAF	MERCED COUNTY SHERIFFS DEPARTMENT	U S ARMY CORP OF ENGINEERS
U S DEPARTMENT OF AGRICULTURE	NEW MEXICO STATE UNIVERSITY	FLORIDA HIGHWAY PATROL TROOP E
TEXAS STATE TECHNICAL COLLEGE	MISSOURI DEPARTMENT OF CONSERVATION	CAMERON PARISH MOSQUITO ABATEMENT DISTRICT NUMBER1
DEPARTMENT OF AGRICULTURE AND CONSUMER SERVICES	COMMONWEALTH OF VIRGINIA DEPT OF STATE POLICE	POLK COUNTY SHERIFFS DEPARTMENT
ARKANSAS FORESTRY SERVICE	COLLIER MOSQUITO CONTROL DISTRICT	MOBILE COUNTY HEALTH DEPARTMENT
CALIFORNIA DEPARTMENT OF HIGHWAY PATROL	CDF AND FIRE PROTECTION	PUERTO RICO DEPARTMENT OF NATURAL RESOURCES
WHIDBEY ISLAND NAVY FLYING CLUB	U S AIR FORCE HOLLOMAN AERO CLUB	U S DEPARTMENT OF INTERIOR FISH AND WILDLIFE
LOUISIANA STATE FORESTRY DEPARTMENT	NAVAJO NATION	PUERTO RICO HIGHWAY AND TRANSPORTATION AUTHORITY
ARIZONA WING CIVIL AIR PATROL	PINELLAS COUNTY SHERIFFS DEPARTMENT	BROWARD COUNTY MOSQUITO CONTROL
MARCH AERO CLUB	UNITED STATES CUSTOMS DEPARTMENT	FLYING AGGIES
TEXAS DEPARTMENT OF TRANSPORTATION	CUSTOM AND BORDER PATROL MIAMI AIR BRANCH	UNIVERSITY OF ALABAMA
NASA LANGLEY RESEARCH CENTER	COMMONWEALTH OF VIRGINIA DEPARTMENT OF AVIATION	RHODE ISLAND AIRPORT CORPORATION
U S CUSTOMS AIR BRANCH	GRANT COUNTY MOSQUITO CONTROL DISTRICT 1	UNIVERSITY OF SOUTH CAROLINA ATHLETICS DEPARTMENT
CIVIL AIR PATROL	UTAH COUNTY SHERIFFS OFFICE	RICHLAND COUNTY SHERRIFS DEPARTMENT
FLORIDA FISH AND WILDLIFE CONSERVATION COMMISSION	U S CUSTOMS ALBUQUERQUE FEDERAL GOVERNMENT	NEW MEXICO DEPARTMENT OF GAME AND FISH
SOUTH CAROLINA COMMISSION OF FORESTRY	UTAH DEPARTMENT OF TRANSPORTATION	RIVERSIDE COUNTY SHERIFF
TARRANT COUNTY JUNIOR COLLEGE	HINDS COMMUNITY COLLEGE	COMMONWEALTH OF VIRGINIA DEPARTMENT OF FORESTRY
U S CUSTOMS SERVICE BRANCH	OMEGA AIR REFUELING SERVICES INC	DEPARTMENT OF INTERIOR
DEPT OF PUBLIC SAFETY OKLA HIGHWAY PATROL AVIATION	COMMONWEALTH OF PENNSYLVANIA BUREAU OF AVIATION	WASHINGTON STATE DEPT OF FISHERIES AND WILDLIFE EN
U S FOREST SERVICE	MT DEPT OF NATURAL RESOURCES AND CONSERVATION	SACRAMENTO POLICE DEPARTMENT
KIRTLAND AIR FORCE BASE AERO CLUB	CALCASIEU PARISH POLICE JURY	MT HIGHWAY PATROL
FAA FLIGHT PROGRAM - COMMERCIAL OPERATIONS	BRAZORIA COUNTY	SALT RIVER PROJECT
MISSOURI STATE HIGHWAY PATROL	TULARE COUNTY SHERIFFS DEPARTMENT	CLEMSON UNIVERSITY ATHLETIC DEPARTMENT
UNITED STATES DEPARTMENT OF COMMERCE	MISSISSIPPI HIGHWAY PATROL STATE OF MISSISSIPPI DE	FRESNO COUNTY SHERIFFS DEPARTMENT
ILLINOIS DEPARTMENT OF TRANSPORTATION DIV OF AERON	UNIVERSITY OF ARKANSAS	COLLIER COUNTY SHERIFFS OFFICE
U S BORDER PATROL	ARKANSAS DEPARTMENT OF TRANSPORTATION	SAN JOAQUIN COUNTY SHERIFFS DEPARTMENT
TEXAS DEPARTMENT OF PUBLIC SAFETY	STATE OF WEST VIRGINIA	JEFFERSON COUNTY
OFFUTT AERO CLUB	DEPARTMENT OF FORESTRY	SAN JUAN COUNTY SHERIFFS OFFICE
FT MEADE FLYING ACTIVITY	BIG CYPRESS NATIONAL PRESERVE	KANSAS DEPARTMENT OF WILDLIFE AND PARKS
CALIFORNIA DEPARTMENT OF JUSTICE	MT AERONAUTICS DIVISION	SANTA BARBARA COUNTY SHERIFFS DEPARTMENT
MINNESOTA DEPARTMENT OF NATURAL RESOURCES	U S DEPT OF AGRICULTURE AGRICULTURAL RESEARCH SERV	DRUG ENFORCEMENT ADMINISTRATION
ADVANCED TRAINING SYSTEMS INTERNATIONAL INC	CALIFORNIA HIGHWAY PATROL	SEDGWICK COUNTY SHERIFFS DEPARTMENT
WESTERN KANSAS GROUNDWATER MANAGEMENT DISTRICT 1	VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSIT	KERN COUNTY FIRE DEPARTMENT
NASA GODDARD SPACE FLIGHT CENTER	EASTSIDE MOSQUITO ABATEMENT DISTRICT	SOUTH CAROLINA AERONAUTICS COMMISSION
EGLIN AERO CLUB	STATE OF TEXAS PARKS AND WILDLIFE DEPARTMENT	DRUG ENFORCEMENT ADMINISTRATION BWI OFFICE
CALIFORNIA DEPARTMENT OF FISH AND GAME	ARKANSAS STATE POLICE	FRESNO POLICE DEPARTMENT
IOWA STATE PATROL	JACKSONVILLE AIRPORT AUTHORITY	BAKERSFIELD POLICE DEPARTMENT
MISSISSIPPI STATE UNIV DEPT OF AEROSPACE ENGINEERI	NEBRASKA DEPARTMENT OF AERONAUTICS	FRESNO WESTSIDE MOSQUITO ABATEMENT DISTRICT
WASHINGTON STATE PATROL	KERN COUNTY SHERIFFS DEPARTMENT	LOS ANGELES POLICE DEPARTMENT AIR SUPPORT DIVISION
DRUG ENFORCEMENT AGENCY	NEW MEXICO STATE POLICE	SOUTH DAKOTA STATE UNIVERSITY
NEW YORK STATE POLICE AVIATION	U S CUSTOMS SERVICE PUERTO RICO	ALBUQUERQUE POLICE DEPT APD SELECTED INVESTIGATION
PENNSYLVANIA STATE POLICE BUREAU OF EMERG SP OPERS	AUBURN UNIVERSITY	MT DEPT OF LIVESTOCK
WJHTC FLIGHT PROGRAM	LOUISIANA DEPT OF ENVIRONMENTAL QUALITY SECRETARY	COMMONWEALTH OF MASSACHUSETTS
U S DEPARTMENT OF AGRICULTURE ANIMAL DAMAGE CONTRO	PIERCE COUNTY SHERIFFS DEPARTMENT	ST LOUIS COUNTY POLICE DEPARTMENT
FEDERAL BUREAU OF INVESTIGATION	MARYLAND STATE POLICE	U S DEPARTMENT OF AGRICULTURE REGIONAL OFFICE
FAA ACADEMY FLIGHT PROGRAM	SACRAMENTO COUNTY SHERIFF AIR OPERATIONS	AIRCRAFT CERTIFICATION SERVICE AIR FLIGHT PROGRAM
U S CUSTOMS SERVICE SAN DIEGO AVIATION BRANCH	USCBP - OFFICE AIR AND MARINE	EL PASO POLICE DEPARTMENT AIR SUPPORT UNIT
PIMA COUNTY SHERIFFS DEPARTMENT	METRO DADE POLICE DEPARTMENT	ARKANSAS DEPARTMENT OF AERONAUTICS
CBP GREAT LAKES AIR AND MARINE	MESA POLICE	U S DRUG ENFORCEMENT AGENCY EL PASO
COLORADO STATE PATROL AIRCRAFT SECTION	ST TAMMANY PARISH MOSQUITO ABATEMENT	STATE OF ALABAMA DEPARTMENT OF AERONAUTICS
U S BORDER PATROL FEDERAL GOVERNMENT	STANISLAUS COUNTY SHERIFF DEPARTMENT	MARIN COUNTY SHERIFFS DEPARTMENT
US CUSTOMS AND BORDER PROTECTION SERVICE	SOUTHERN ILLINOIS UNIVERSITY SIU	STATE OF ALABAMA DEPARTMENT OF GAME AND FISH
ARIZONA GAME AND FISH DEPARTMENT	TULARE MOSQUITO ABATEMENT DISTRICT	NEVADA DEPARTMENT OF WILDLIFE
STATE OF TENNESSEE DEPARTMENT OF TRANSPORTATION	MASSACHUSETTS STATE POLICE AIRWING	CITY OF STUTTGART
MINNESOTA DEPT OF PUBLIC SAFETY AND STATE PATROL	U S DRUG ENFORCEMENT AGENCY ALBUQUERQUE	NEVADA F B I
STATE OF ALABAMA FORESTRY COMMISSION	OFFICE OF THE GOVERNOR OF KANSAS	ALAMEDA COUNTY SHERIFFS DEPARTMENT
STATE OF ALABAMA DEPARTMENT OF PUBLIC SAFETY	TARRANT COUNTY WATER CONTROL AND IMPROVEMENT	UNIVERSITY OF SOUTH CAROLINA
CONNECTICUT STATE POLICE AVIATION UNIT	CHARLOTTE COUNTY SHERIFFS DEPARTMENT	GREENVILLE COUNTY SHERIFFS OFFICE
UTAH DEPARTMENT OF AGRICULTURE	MISSOURI STATE HIGHWAY COMMISSION	UNIVERSITY OF SOUTH DAKOTA
PHOENIX POLICE AIR SUPPORT	OKLAHOMA DEPARTMENT OF TRANSPORTATION	HIGHLANDS COUNTY SHERIFFS DEPARTMENT
STATE OF KANSAS HIGHWAY PATROL	UNIVERSITY OF MISSISSIPPI FLIGHT OPERATIONS	MASSACHUSETTS AERONAUTICS COMMISSION
U S DEPARTMENT OF AGRICULTURE FOREST SERVICE	OKLAHOMA STATE DEPARTMENT VO TECH	STATE OF MISSISSIPPI OFFICE OF AIR TRANSPORTATION
STATE OF MINNESOTA DEPARTMENT OF TRANSPORTATION	NEW YORK STATE POLICE	USDA FORESTRY SERVICE AVIATION AND FIRE MANAGEMENT
ARIZONA DEPARTMENT OF PUBLIC SAFETY	OKLAHOMA UNIVERSITY	STATE OF NEW MEXICO GEN SERVICES ADMIN SVC BUREAU
NEBRASKA STATE PATROL	TEXAS ENGINEERING EXPERIMENT STATION	BUTTE COUNTY SHERIFFS DEPARTMENT
NASA FEDERAL GOVERNMENT	FEDERAL BUREAU OF INVESTIGATION ALBUQUERQUE	HILLSBOROUGH COUNTY SHERIFFS DEPARTMENT
MT DEPT OF FISH WILDLIFE AND PARKS	KERN MOSQUITO ABATEMENT DISTRICT	COMMONWEALTH OF VIRGINIA MARINE RESOURCES COMMISSI
METRO AVIATION UNIT	OSCEOLA COUNTY SHERIFS DEPARTMENT	STATE OF SOUTH DAKOTA PUBLIC SAFETY
TBM INC	COMMONWEALTH OF PENNSYLVANIA ATTORNEY GENERALS OFC	WASHINGTON STATE DEPT OF AERONAUTICS
ILLINOIS STATE POLICE AIR OPERATIONS	PA DOT PHOTOGRAMITRY AND SURVEYS	CLACKAMAS COUNTY SHERIFFS OFFICE
DEPARTMENT OF STATE POLICE	MARYLAND DOT/MAA	MONTGOMERY COUNTY DOT
UNITED STATES DEPT OF INTERIOR MARYLAND OFFICE	FEDERAL BUREAU OF INVESTIGATION BWI OFFICE	MT GOVERNORS OFFICE
MARICOPA COUNTY SHERIFFS OFFICE AVIATION SUPPORT U	UNIVERSITY OF TEXAS	CHAMBERS COUNTY
MERCED MOSQUITO ABATEMENT	FEDERAL BUREAU OF INVESTIGATION EL PASO	CLEMSON UNIVERSITY
COLORADO DIVISION OF WILDLIFE	VIRGINIA STATE POLICE HELICOPTER UNIT	YAVAPAI COUNTY SHERIFFS DEPARTMENT
PUERTO RICO POLICE DEPARTMENT	PICKENS COUNTY SHERIFFS OFFICE	MT DEPT OF TRANSPORTATION
SAN BERNARDINO COUNTY SHERIFFS AVIATION DIVISION	TANGIPAHOA MOSQUITO ABATEMENT DISTRICT	MONROE COUNTY SHERIFFS OFFICE
LOUISIANA DEPARTMENT OF WILDLIFE AND FISHERIES	COUNTY OF PLYMOTH	

Part 137

AURORA COOPERATIVE ELEVATOR COMPANY
WILBUR-ELLIS AIR LLC
DYNAMIC AVIATION GROUP INC
TAYLOR AVIATION INC
NEW FRONTIER AVIATION INC
JONES AVIATION INC
WOODLEY AERIAL SPRAY INC
NEPTUNE AVIATION SERVICES INC
WILBUR-ELLIS COMPANY
M AND M AIR SERVICE OF BEAUMONT INC
AIR DAKOTA FLITE INC
AL'S AERIAL SPRAYING LLC
ALLEN CHORMAN AND SON INC
DOWNSTOWN AIRPORT INC
CURLESS, HARLEY JOE
CHORMAN SPRAYING LLC
CHESTER FLYING SERVICE INC
J AND L SMITH FARMS INC
ATLANTIC AG AVIATION INC
TRI-ROTOR SPRAY AND CHEMICAL INC
TRI-ROTOR CROP SERVICES LLC
ROSS SEED COMPANY INC
O'BRIENS FLYING SERVICE INC
FARM AIR SERVICE INC
VECTOR DISEASE CONTROL INTERNATIONAL LLC
QUEEN BEE AIR SPECIALTIES INC
AIR KRAFT SPRAYING INC
FARM BROTHERS FLYING SERVICES LLC
T AND T AVIATION INC
HARING, CLAY A
AERO SPRAY INC
ROTH AG-AIR INC
AG AIR INC
REABE SPRAYING SERVICE INC
MEYER, JOEL LYNN
ROTH AERIAL SPRAYING INC
DETERDING, JAMES LOUIS
HAP CO
AIR AG INC
EVERGREEN FLYING SERVICE INC
HEINEN BROTHERS AGRA SERVICE INC
UNITED STATES DEPARTMENT OF AGRICULTURE
HENRYS AERIAL SERVICE INC
HOG AIR AVIATION INC
AGRI FLITE SERVICES INC
PRO AIR SERVICE INC
NC DEPT OF ENV AND NAT RESOURCES FOREST RESOURCES
THIEL AIR CARE INC
HOLZWARTH, CHARLES H
AERO TECH INC
HOPPE AIRSPRAY LLC
AMERICAN AG AVIATION INC
WILLIAMS, CLARENCE
HENDRICKSON FLYING SERVICE
KENNYS CROP DUSTING INC
NCFE CUSTOM AIR, LLC
AVAG INC
PORTER FLYING SERVICE INC
BARTS FLYING SERVICE INC
REBECCA LYNN FLYING SERVICE INC
LAKELAND DUSTERS AVIATION INC
TALL TOWERS AG SERVICE INC
LINDELL AERIAL AG SERVICE
VALLEY AIR SERVICE LTD INC
LOWRY FLYING SERVICE INC
MORRIS AG AIR SOUTHWEST LLC
PLAINS AERIAL APPLICATORS INC
TOLLES FLYING SERVICE INC
SIDES AVIATION LLC
GLADE AG SERVICES INC
CUSTOM AIR INC
BENOIT AERIAL SPRAYING INC
AG AIR LLC
VALLEY AIR LLC
HRABE FLYING SERVICE INC
SARITA AERIAL CONTRACTORS INC
FARM AND RANCH AERIAL SERVICE INC
SUTTER BUTTE DUSTERS INC
INTERNATIONAL AIR RESPONSE INC
MARK GARY FLYING SERVICE INC
CENTRAL PLAINS SPRAYING INC
COUNTRYSIDE AVIATION LLC
WEST WIND AIR LLC
CARSON FLYING SERVICE INC
WESTERN COOPERATIVE COMPANY
GOWERS AIR SERVICE INC
AERO FLITE INC
SCOTT, KYLE
PRECISSI FLYING SERVICE INC
SUNFLOWER FLYING LLC
JOHNSON, LINDLEY C
HICKS, LOWELL R
FISHERS AGRICULTURAL SERVICE
ARROW FLYING SERVICE INC
R AND M SPRAYING SERVICE LTD
TINNES, ALLEN H
G B AERIAL APPLICATIONS INC
HAUGHEY, HAL W
LINDEMAN, RUSTY

AGRICAIR LLC
HALE AVIATION INC
WILLIAMS FERTILIZER SERVICES L L C
BOBS FLYING SERVICE INC
ASI JET AG LLC
HANSEN, DOUGLAS M
WILLMES FLYING SERVICE INC
ROMA AIR CORPORATION
DANIEL, JAMES ANTHONY
AG AVIATION
BONNE IDEE AERO SERVICES INC
L AND W FLYING SERVICE
LAKE AIR SERVICE LLC
KIDD, CLIFFORD L
BROWN, MAX KEVIN
COLLINS, WAYNE
CARRANZA, CHRIS
COOPER FLYING INC
PACIFIC AG SERVICES INC
CORBETT CROP DUSTING LLC
SHERMAN AVIATION INC
CORPORA AERIAL SERVICE INC
TURMAN AVIATION
COTTON AG INC
MONTROSE AIR INC
COUNTRY AIR SERVICE INC
BREKKE AERIAL SERVICE INC
COUNTY LINE FLYING SERVICE INC
RUNSICK, MICHAEL CHAD
AIR COVER CROP SOLUTIONS LLC
SOUTHERN AIR SERVICES LLC
CRAFT AIR SERVICE LLC
THORNTON, BUSTER L
CRAIG AIRSPRAY INC
WEBB FLYING SERVICE INC
CROOM, KENT
MIKE HARMON AVIATION LLC
CROP AIR INC
NORMAN, GRADY B
CROP CARE AERIAL SPRAYING LLC
PETERSON, KENNETH J
CROP CARE INC
BRIAN, MURRAY JOSEPH
CROP DOCTOR AVIATION INC
RIDGEWAY, RICK
AIR DUSTER INC
SCIARA AND WHITTINGTON AIR AND GROUND LLC
AERIAL CROP SERVICES LLC
SLATER SPRAY SERVICE INC
CROP-SERV INC
STEGGS AERIAL SPRAYING INC
5-G AVIATION LLC
T AND M AVIATION INC
D AND K AG SERVICE INC
TRANS AG INC
DAKOTA AIRCARE INC
WADE, MIKE
DALES FLYING SERVICE INC
WESTERN AG AVIATION INC
DELTA DUSTERS II LLC
CONE AG AVIATION LLC
DELTA DUSTERS LLC
MILLS AG SERVICE
DENTON AERIAL SPRAYING INC
MOUNTAIN AIR SPRAY CO
DENTON, LARRY E
OLEEN, GARY
DETERDING, ANDREW
PATRICK, LAWRENCE ALVIN
AERIAL FARMING SERVICE INC
PIONEER AGVIATION INC
DIXIE FLYING SERVICE
PROBASCO FLYING SERVICE INC
DIXON AVIATION L L C
RANCH AERO INC
DONOVAN, PATRICK L
REYNOLDS, ERNEST C
DONOVAN, STEVE
BUNKIE FLYING SVC
DOUG KROEPLIN FARMS LLC
SATTERWHITE, JOHN HULET
DUFLO, JEFFREY T
SES AVIATION LLC
DUNN, BLAKE C
CARAWAY, DARREL
EARLIMART DUSTERS INC
SMITH, KELLY P
EARLS SPRAY SERVICE INC
SPRAYERS INC
EAST BATON ROUGE MOSQUITO RODENT CO
STODDARD, LEVI
EAST RIVER FLYING SERVICE LLC
SUNFLOWER AERO INC
EASTERN AERIAL APPLICATIONS LLC
THISIUS FLYING SERVICE LLP
EBERT FLYING SERVICE INC
CHANAY AIRCRAFT SERVICES INC
EMPTY POCKETS FLYING SERVICE INC
TRIPLE F FLYING INC

WASHINGTON LIQUID FERTILIZER COMPANY INC
MANN, PETER D AND JEAN K
WEAVER FLYING SERVICE INC
MARBURGER ENTERPRISES INC
WELDON FLYING SERVICE L L C
MARKES AG AIR SVC
WERTH, JOHN F
BETA AG INC
WEST CENTRAL AG-AIR INC
MCCOOL AIR SERVICE INC
WESTERN AG AIR INC
MCCORMACK, TIM DUB
WHEATON-DUMONT AERIAL SPRAYING LLC
MCINTYRE FLYING SERVICE
WHITEFACE AVIATION CO
MEYER FLYING SERVICE INC
WHITFIELD, ROBERT O JR
BLACK HAWK AIR LLC
COCHERAN, WILEY M
MICHAELIS, GARY
WISE, JERRY LEE
BLACKLEDGE, HAROLD RAY
WOOD, THOMAS A
MID-CAL AG AVIATION INC
WOODWARD, JACK H
MIDDLE GEORGIA AVIATION INC
YELLOWSTONE AIR SERVICE
MID-STATE AVIATION II INC
MIDWEST AIRSPRAY LLC
MIDWEST FLYING SERVICE INC
H AND H FARMS NUMBER 2
R E PETTIS AERIAL APPLICATOR
TURRELL FLYING SVC
HOELSCHER AG SPRAY INC
GOTHENBURG FLYING SERVICE INC
DREAMSTREET AVIATION INC
TERHUNE FLYING SERVICE INC
HOFERS AG AIR INC
WINEMILLER FLYING SERVICE INC
ATCHLEY, JOSHUA
GLINZ, MARK N
HOGG, GLENN WILSON
SHEPARD, ROBERT BANKS
HOISTAD FLYING SERVICE INC
STRATFORD FLYING SERVICE
HOLCOMB AERIAL SERVICE INC
TLB AIR LLP
HOLCOMB, BEN
WAYNE AERIAL CROP SPRAYING
D'SPAIN, BILLY J
PRO-AIRE LLC
HOLTE, JAMES K
DELTA AG SPECIALIST INC
AUBURN RAVINE APPLICATORS
BURGESS, RONALD KEITH
HOMESTEAD FARMS FLYING SERVICE INC
SCHROEDER, MICHAEL L
AERIAL CROP PROTECTION INC
AIR TRACTOR INC
AUFDERHEIDE FLYING SERVICE INC
STANFORD FLYING SERVICE INC
HOPPE, FRANCIS DUANE
SWOPE, C D JR
HORAN SPRAYING LLC
HARTSOCK FLYING SERVICE
HORNE, BRADLEY R
TRI-COUNTY AERO INC
DUNGAN AERIAL SERVICE INC
VENELL FARMS INC
HOWARD FLYING SERVICE
WHITAKER AERIAL SPRAYING INC
DYER, ROBERT GUY
YOUNG, GEORGE EARL JR
E AND B AVIATION INC
ANDERSON FLYING SERVICE LLC
HUGHES, BRIAN D
ANDERSON, DUSTIN
E R FRYE UNIT 4 INC
GIRDLEY FLYING SERVICES INC
EAGLE AVIATION INC
DEMARS, KEVIN L
IGLEHART, STEPHEN R
GOODMAN FLYING SERVICE INC
CROPAIR FLYING SERVICE INC
C V A INC
CROPDUSTERS INC
SEMINOLE AVIATION INC
INGEBRETSON AIRSPRAY INC
SIMPSON AVIATION AND AGRICULTURE INC
INLAND CROP CARE LLC
SMITHY GRAIN INC
COULSON AVIATION USA INC
SPARKS, DALE E
AVERY, WALTER
DISTANT FARMS INC
EAST RIVER AIR SPRAY LLC
CARSON AIR SERVICE
J AND K FARMS INC
TALLMAN, JOHN D

COEN AERIAL SPRAYING
FARMERS AERIAL SEEDERS CORP
WILSTINE FARM SUPPLY INC
BENNY WHITE FLYING SERVICE INC
WINGER, KEVIN
LUX, JEFFREY KYLE
DOYLE, VIC
D S DUSTERS INC
WOOLSLAYER, JOE P
FAUNCE AIR LLC
DRATH AIRCRAFT SERVICE
M AND J FLYING SERVICE L L C
ZERBE, GRANT
M AND K FLYING SERVICE INC
GAERTE AG SERVICE LLC
M AND M AIR SERVICE INC
BREKKE AVIATION INC
FAUNCE, GREGORY R
PRO-AGRI SPRAYING INC
BENTHIEN, BRUCE
GARDNER, CLIFFORD ROBERT JR
FAUST, DAVE
CONFEDERATE AIR INC
FEDERICO HELICOPTERS INC
PURVIS FLYING SERVICE
MACHART, JOHN H
GARRETTS FLYING SERVICE INC
BENTON FLYING SERVICE INC
QUIVER RIVER FLYING SERVICE LLC
MAD FLY INC
BRIGHT, CHARLES
AERIAL FARMER LLC
R AND R FLYING OF LAKE PROVIDENCE INC
MANN AGRI SERVICES INC
R AND S FLYING LLC
FENGER, JOEL H
RAINEY, SCOTT
COPENHAVER, TRACY K
RAM AIR LLC
MARKED TREE FLYING SERVICE INC
RANDALL, LARRY H
CRABBE, W CARTER
RAU, BRIAN
MARQUART, DANNY ALLEN
BROWN AERIAL AG SERVICES LLC
MARTIN, GARY
RED RIVER AERO INC
MARTIN'S DUSTERS INC
RED RIVER SPRAY SERVICE LLC
MATHIAS, JON
REDER AG AIR LLC
MATHIAS, RICHARD L
DELTA AIR INC
BERTRAND SPRAYING LLC
ANDERSON, JAMES DAVID
FERRSPRAY AERIAL APPLICATION LLC
REIM SPRAYING SVC
BETS AGRICULTURAL FLYING SERVICE LLC
GILDER FLYING SERVICE INC
MAXWELL FLYING SERVICE INC
ANDERSON, JOEL M
BETTERFLY INC
GLEASON, FRANKLIN R
FIELDGROVE, MATT
RICHELDERFER AIR SERVICE INC
MCCORMICK SPRAYING SERVICE
GLENN AIR INC
MCCRAY FLYING SERVICE INC
RINGS AERIAL SPRAYING INC
BEVING, MARTIN L
RIVERSIDE AIR LLC
AG NORTHWEST INC
BUMGARNER, CURT
BILL POOL SPRAYING INC
ROCKY MOUNTAIN AG INC
MCKAY, DENNIS E
GODWIN, M G
MCMILLIAN, BENNETT L
BUNTINGS DUSTING INC
MCNEILL, DUDLEY
RONALD J AERIAL APPLICATIONS
BIRD ENTERPRISES LLC
ROSEDALE FLYING SERVICE INC
MCPHERSON, TRAVIS CARL
ADVANTAGE AERO AG
MEEKER AIRPORT INC
ROWLAND FLYING SERVICE INC
BI-STATE AIR INC
ROYS AERIAL SPRAYING INC
MEINES ENTERPRISES LLC
BUTLER, KEN R
MELBY, MICHAEL D
RUSSELL SPRAYING INC
MEREDITH FLYING SERVICE LLC
RUTLAND, JERRY DAVID
MERRILL, ROBERT DIRK
RZ AG AIR INC
METTLER AERIAL INC
S AND V AERIAL INC

HELM FLYING SERVICE INC
RICHTER AVIATION INC
MCCLARY, GUY E
ROGERS, RONNY JOE
MINUTEMAN AERIAL APPLICATION INC
GASPER AIR SPRAY
AIRBORNE CUSTOM SPRAYING, INC
PLANE CENTS AVIATION LLC
KLINKENBORG AERIAL SPRAYING AND SEEDING INC
KNUTSON FLYING SERVICE INC
KUBECKA FLYING SERVICE
TOPFLIGHT AVIATION INC
SONGER, HARVEY
MACYS FLYING SERVICE INC
MCCLUNG AERIAL SPRAYING INC
TAYLOR AG SERVICES INC
MCGINTY FLYING SERVICE INC
FOUNTAIN FLYING SERVICE-GENESEE LLC
CENTRAL ALABAMA FLYING SERVICE INC
JURAK, BERTON DALE
GREEN MEADOWS AVIATION LLC
SUNNILAND AIRCRAFT SALES INC
HALEY FLYING SERVICE
TIM WHITFIELD AVIATION INC
AIR ADVANTAGE INC
FLYING G AVIATION INC
ARKLA FLYERS INC
WAKEFIELD, JOHN
NEBRASKALAND AVIATION INC
SCHERTZ AERIAL SERVICE INC
HAR-MOR AG AIR INC
BLAIR AIR SERVICE INC
HATFIELD SPRAYING SERVICE INC
STEIER AG AVIATION INC
NYSSA AG SERVICE INC
FARROW, SAMMIE JR
AERIAL CROP CARE CO
WOOD, JAMES F
OLATHE SPRAY SERVICE INC
TODDS FLYING SERVICE INC
OLI GROW LLC
TRI-COUNTY SPRAYERS INC
PALMER FLYING SERVICE INC
TWIN EAGLE'S AVIATION INC
AERO AIR LLC
LYNDEN AIR CARGO L L C
CRABBE AVIATION LLC
WESTERLIN AND HARRINGTON FLYING SER
PLATH, JAMES F
MAUCK FLYING SERVICE LLC
AIR FARM INC
SCHIFFER, MICHAEL
A AND M FLYING SERVICE INC
SHANNON AGRICULTURAL FLYING INC
HERITAGE AG LLC
SIDES, MICHAEL E
QUALITY AVIATION INC
SOUTH DELTA AVIATION INC
QUALITY SPRAYING SERVICE INC
KING AG AVIATION INC
DAKOTA AG SERVICE INC
BOB RUHE AG SERVICE INC
DESERT AIR AG INC
KUBALS AERIAL SPRAYING INC
R AND W FLYING INC
WILLIAMS, DELBERT D
B AND R AERIAL CROP CARE INC
THOMPSON AERO INC
DEVIL DUSTERS INC
BOEDEKER FLYING SERVICE INC
RED WILLOW AVIATION SPRAYING INC
FLETCHER FLYING SERVICE INC
REED AVIATION INC
TORKELSON, CHARLES A
REGIER FLYING SERVICE L L C
LEE COUNTY MOSQUITO CONTROL
AG AIR SERVICE INC
TWIN COUNTY AIR-AG INC
RIGGIN, MORRIS
FOUNTAIN FLYING SERVICE INC
ROBERTSON CROP DUSTING SERVICE INC
LUTTER, JAMES
IMPERIAL FLYING SERVICE
VINCENT FLYING SERVICE INC
ROSS FLYING SERVICE INC
BOYLE FLYING SERVICE INC
BECKER FLYING SERVICE INC
M J AVIATION INC
ED AIR INC
BRETTS SPRAY SERVICE INC
ABERNATHY SPRAYING SERVICE INC
AGRI-AIR INC
BIXENMAN, KENNETH JAY
KYLE E RICH INC
YOST, RANDY A
SRB AERIAL APPLICATORS LLC
WILSON, BARRY J
TRINKLE AG FLYING INC
DARTER, LLOYD R
SCOTT, RANDY
AIRSTRYKE INC
VALLEY SPRAYERS INC
ESCOTT, TANNER R.
WALTON, PHILIP G
EVANS AVIATION INC
WEST AVIATION INC
AIR-TRAC INC
COATES FLYING SERVICE INC
EVERGREEN AVIATION LLC
WOODS AVIATION INC
F W F INC
MIDWEST SPRAY SERVICE LLC
FAIRMONT AERIAL AG INC
MILES FLYING SERVICE
FARM AND RANCH AVIATION CO
BLAIR, BOB JR
FARMER AERIAL AG LLC
MORRIS FLYING SERVICE INC
ALBRIGHT, FRANK
NEWTON, DONALD H
ALEXANDER AG FLYING SERVICE INC
OKANOGAN AIR SERVICE INC
ALLEN AVIATION INC
ORWICK, LOUREN CHRIS
FERGUSON FLYING SERVICE INC
PADGETT, JEFF
FERRIDAY FLYING SVC
BONNERS AERIAL APPLICATOR INC
FISHER FLYING SERVICE LLC
PHILLIPS DUSTING SERVICE INC
FLAGLER AERIAL SPRAYING INC
POLRIES, LARRY J
ALLIED SPRAYERS INC
PRICE, WILLIAM BELTON
FLYING E SPRAYING SERVICE LLC
PURYEAR, RODNEY K
ALLRED AVIATION
R A S INC
FOLDEN AVIATION INC
RECK AVIATION INC
FOREST FLYING SERVICE INC
BROWN, SHERRIE CARTER
FRIESENBORG AND LARSON CUSTOM SPRAYING LLC
BRUNETTI, FINLEY JR
FRONTIER AGRICULTURAL SERVICE INC
ROBERTS FLYING SERVICE
G AND G FLYING SERVICE INC
BURNETTE AVIATION INC
AERO APPLICATORS INC
SABBE BROTHERS FLYING SERVICE INC
AERO CHARTER EXPRESS INC
SCHNEIDER, STEVEN M
GARRETT FLYING SERVICE
CAMPBELL AERIAL SPRAYING INC
GAUDRY AG SERVICE INC
SHENANDOAH FLIGHT SERVICE INC
GEIST, DANIEL
SHUPE FLYING SERVICE INC
GEORGESON, QUENTIN NUEVELLO
SKALITSKY, LARRY AND JAMES
GERIK CUSTOM AG SERVICE
SMITH COMPANY FLYING SERVICE INC
GIBBS, LUTHER A
CARLSON'S AG AVIATION INC
GILBERT AVIATION INDUSTRIES INC
SOUTHLAND FLYING SERVICE INC
GLOVER AVIATION INC
STARDUST AG AVIATION
GORDER, MARK
STEVENSON AERIAL SPRAYING
ANDY RIDDELL FLYING SERVICE INC
STORM SPRAYING SERVICE INC
GRACE FLYING SERVICE INC
STURGEON, PHYLLIS AND WARREN
GRAND PRAIRIE DUSTERS INC
SUNRISE DUSTERS INC
GRAY AG AIR
CE-AIR INC
GREAT PLAINS AERO INC
CENTRAL AIR SVC
GREGS CROP CARE CO
AERIAL CROP CARE INC
GRIFFIN AG INC
TOP HAT AG L L C
GRUBBS, TERRY L
CHESAPEAKE AG AIR
GULF COAST AIR INC
TRONSDAL, CURT
H AND H AVIATION INC
UHLAND, STEVE
HAGGART, TERRY L AND JAMES E
VISCO FLYING COMPANY
HALL, JOHN MARK
WALKER AVIATION LLC
HAM, ORLANDO
WATSON AIR FARM LLC
HAMLIN FLYING SERVICE INC
CLEVELAND AIR SERVICE INC
HAMMOCK, JASON
COASTAL FLYING SERVICES INC
J DS FLYING SERVICE INC
DONOVAN, BRIAN W
JACK OLDHAM OIL INC
CENTRAL INDIANA AG SERVICES INC
JACKSON COUNTY SPRAYING SVC
CHAPMAN, TROY ALTON JR
JAMES, JEFFREY WILLIAM
HEIDERSCHEIDT AERIAL LLC
JAMES, RICHARD
VALLEY AERIAL SPRAY INC
CROSS, RICHARD
CLARKS AG LLC
JAREDS FLYING SERVICE INC
A AND M FLYING SVC
JARRETT AIRSPRAY INC
COBB AERIAL SOLUTIONS
JASON SCHINDLER FLYING INC
CONE AERIAL SPRAYING INC
JAY FLYING SERVICE INC
PRIME AIR LLC
EASTERN CAROLINA AVIATION SERVICE LLC
PRUITTS FLYING SERVICE INC
AVIATION SERVICES OF GRADY COUNTY INC
GAUMNITZ FLYING SERVICE INC
JEFFS AIRSPRAY
DEBILT, WILBERT
EASTERN FLYING SERVICE INC
RED RIVER DUSTING INC
JERGER, GARY
REID AVIATION AND AERIAL SPRAYING LLC
JERRYS FLYING SERVICE
BRUNTZ AVIATION INC
ECKLES, WILLIAM PHILLIP
ROBERTS AG AIR SERVICE INC
JIMAIR INC
ROME, JAMES R
JIRAK, JERRY DEAN
BURT AND BUNN FLYING SERVICE
JOE VAUGHN SPRAYING INC
DEMPSAY, WILLIAM A
JOHANSON, MARK E
ANDERSON, STEPHEN
JOHNSON AIR SERVICE INC
CRAWFORD AVIATION SERVICES LLC
JOHNSON FLYING SERVICE
AIR SPRAY AVIATION SERVICES USA
JOHNSON FLYING SERVICE INC
SHARAR FLYING SERVICE INC
JOHNSON LAKE FLYING SERVICE INC
GRIGSBY AG SERVICE LLP
JOHNSON SPRAY SERVICE INC
CARLSON, BRYON L
JOHNSON, BOBBY DALE
SMITH, DAVID C
JOHNSON, DANIEL D
DEWITT, RANDY
ED'S FLYING SERVICE INC
H AND P FLYING SERVICE INC
JOHNSON, KENDALL M
SPRAY RITE OF IDAHO INC
AESCHLIMAN, ARLIE L
STEEN, DAVID A
B AND S AIR INC
DIVERSIFIED SPRAYING LLC
JONES, CHRIS
STROM, KERRY
JONES, DOYLE RICHARD
CARTILLAR ENTERPRISES INC
JONES, JAMES A
CARTILLAR, J R
JONES, STEVEN L
TAYLOR, GUY W
JORDAN, HORACE A JR
CENEX OIL CO
ELLINGSON AIRCRAFT SERVICE INC
CENTRAL AG SPRAYING INC
K AND P FLYING SERVICE
THOMPSON, ROGER A
ELLINWOOD FLYING SERVICE INC
ASAAP INC
ELLIS AVIATION LLC
COODYS SPRAYING SERVICE
ELLIS, MARK
ASAP FLYING SERVICE INC
KEAHEY FLYING SERVICE OF COLUMBIA INC
HEBBELMANN, JOHN H
3B FARMS INC
TSCHEPEN, RONALD E
KEITH, ARLYN
ULEN AVIATION
KELLEYS FLYING SERVICE
CIRCLE-S AVIATION
KELSCH, REX J
VOLLMER, KENNETH R
CUSTOM AG AND AIR INC
WATEROAK AVIATION LLC
KENDRICK, RAYMOND B
WEBBS FLYING SERVICE INC
BAILEY FLYING SERVICE OF PLAINVIEW LP
WHATLEY, RICHARD E
FIREFLY SPRAYING LLC
SAFFER SPRAY SERVICE INC
BI-STATE HELICOPTERS INC
SALES, JOE H
MEYERKORTH AVIATION LLC
C J AERO SPRAY LTD
AG SPECIALTIES INC
SCHAAK, JAMES D.
FIRST STATE AG AIR INC
DENT, THOMAS E
BLACKBURN FLYING SERVICE INC
SCHLATER FLYING INC
MID MISSOURI SPRAY SERVICE LLC
SCHNOOR AG AND AIR LLC
FIRST STATE COMPANY INC
SCHOTT AG AIR LLC
DALLUGE AERIAL SPRAYING INC
CRIDER, RAYMOND K JR
MID-CONTINENT AIRCRAFT CORP
SCOTT PRECISION AERIAL LLC
AERIAL SPRAYING SERVICE INC
SECKERSON AERIAL SPRAYING LLC
MIDDLETON, ROBERT A
SEITZ, A WAYNE
FITCHETT, BRADLEY
SEMPER FI AVIATION LLC
MIDWAY-AIR
SHADOWENS, JACKIE
MIDWEST AG INC
CANDO AIR LLC
DAN AERO INC
GREGORY AERO SERVICES
MIDWEST AVIATION DIVISION OF SOUTHWEST AVIATION IN
CORNING FARM SUPPLY INC
FLATEN FLYING SERVICE
SHIVERS, BOB M
FLATLAND AVIATION LLC
GROSS, STEVEN W
MIKE SMITH AERIAL SPRAYING INC
SILVERWINGS AG, LLC.
FLINT RIVER DUSTERS INC
GROWERS AIRE SERVICE LLC
ALLRED AERIAL SERVICE LLC
CARLSON AERIAL INC
FLOYD, JAMES R
SKYLINE AGRINAUTICS INC
BLAIN, MONTE WADE
DEV AIR INC
MILLER FLYING SERVICE INC
CARLSON, CORY
MILLER, JEROLD R
SMITH AVIATION INC
MILLER, TIMOTHY J
GUST, DAVID
MILLER, WADE
SMITH, MICHAEL D
MILLS SPRAYING SERVICE INC
SNOW BRAKE AIR SERVICE
AG-AERO SERVICES LLC
SOLLENBARGER, BENJAMIN STUART
DANIELS AVIATION
SOUTH AIR FLYING SERVICE INC
FLYING FIREMAN
SOUTH PLAINS AERO INC
MITCHELL, DAVID K
SOUTHER CROP SPRAYING INC
DANLEY BROTHERS
H AND H FLYING COMPANY
MONTICELLO FLYING SERVICE INC
SOUTHERN AIRWORKS INC
FLYING ILLINI AG SERVICES LLC
SPARKS BROTHERS DRILLING COMPANY
FLYING J AVIATION LLC
SPEAS AVIATION INC
MORGENROTH, DARDON L
SPRAGUE, ROBERT J
AG-AIR INC
AIR-AG INC
BLECH, ANDREAS JEFFREY
SPURLOCK, RICKY
FLYING S AVIATION
HAHN, CAYLE D
MORRISON, MARSHALL
ARENA PESTICIDE MANAGEMENT INC
BLILIE, DENNIS
HALE DUSTING SERVICE INC
MORTEN, JESSE L
STEVEN BALLARDS CROP DUSTING SERVIC
BLUE HIGHWAYS INC
DITTMER AERIAL SPRAYING INC
FLYING W AG INC
HAMILTON, RANDEL L
MOSS, JIMMY DAVID JR
DIXIE CROP CARE INC
MUELLER AVIATION LLC
STRATEGIC AIR LLC
MUNDELL, TERRY D
HAMPTON AVIATION LLC
MURDOCH AERIAL SPRAYING LLC
CROOM, LEON D II

LARSON AVIATION INC
THOMAS HELICOPTERS INC
DAVIS, MICHEAL DEAN
WEISER AIR SERVICE INC
LEE FLYING SERVICE INC
RUSSELL, LARRY
LESMEISTER, DEAN
SIMPSON, TOMMY
LEWIS FLYING AND MAINTENANCE SVC
CEDAR CREEK SPRAYING SERVICE INC
AGRI-TECH AVIATION INC
JEFF STREETER MOTORSPORTS INC
AERO-AG SERVICES INC
KEN-SPRAY INC
LINDEN, VANCE
WHITES FLYING SERVICE INC
LONGWOOD FLYING SERVICE INC
ROWLAND, B S
LOSSE, RANDELL
SCHINDLER FLYING INC
LOVGREN, DEAN
SHORES AG AIR INC
LOW-GO FLYERS INC
SLY, DUANE D JR
AESCHLIMAN, ARLIE WAYNE
AG FLYERS INC
LUTES FLYING SERVICE INC
TAYLOR, STEVEN
DICKSON, SHANNON LOUIS
THREE RIVERS SPRAYING INC
LUX, DAVID J
JERSEY DEVIL DUSTERS LLC
DONALDS FLYING SERVICE INC
AERIAL FARM SERVICES LLC
DOUBLE R FLIGHT SERVICE
KLEIN FLYING SERVICE INC
AVIATION FLYING SERVICE INC
WEST SIDE AERIAL APPLICATORS LLC
AIR AG LLC
KUTSCHERA, THEODORE C
BAILEY FLYING SERVICE INC
BOYD'S AVIATION
MATTERN, RODNEY MARK
RUCHERT, DENNIS E
EDWARDS FLYING SERVICE INC
AIRPRO AVIATION INC
MAX BIRNEY AERIAL SPRAYING INC
SCHWEND, BRIAN
ENVIRONMENTAL AVIATION SERVICES INC
SHEARER SPRAYERS INC
EVERETT FLYING SERVICE INC
CAIN, LELAND
MCELWAIN, FLOYD W
SKY TRACTOR SUPPLY COMPANY LLC
MCGARITY FLYING SERVICE LLC
CANAM AVIATORS INC
BAKER, BEN P
STRATTON EQUITY COOPERATIVE CO
MCMILLAN, ROBERT JR
HOLLY GROVE FLYING SERVICE INC
MCPHERSON, JERRY E
HOUSTON, RICKY J
MEHLING, ROBERT C
TEXOMA AG FLYING SERVICE INC
FARM AIR FLYING SERVICE INC
THOMPSON FARM AIR LLC
MEYERS AERIAL SERVICE LLC
CENTRAL VALLEY AVIATION INC
MICHAELIS, ARVID
TOMMYS FLYING SERVICE INC
MICHAUD, REGENALD S
TRI-COUNTY AG SERVICE INC
MID MICHIGAN HELICOPTERS INC
ANDERSON AERIAL SPRAYING SERV INC
MID MO AG AIR LLC
TWO RIVER AIRSPRAY LLC
MIDWEST AG-AIR INC
KINDER AG SERVICE INC
MILLER AVIATION INC
WALLIN AGRICULTURAL AVIATION
MINDEN AIR CORP
WELLS FLYING SERVICE INC
BARAZANI, JACOB
KMC INC
MORRIS AG AIR AND SONS INC
ASCEND AG INC
BARHAM BROTHERS INC
WILLMAR AERIAL SPRAYING INC
MORTEN, DAVID J
ZUMWALT, ADAM
MORTEN, JOHN E
HARTLEY FLYING SERVICE INC
FARM AVIATION INC
RUBBERT AERIAL INC
AIR AIDS INC
RUCKER BROTHERS FLYING SERVICE INC
FARMERS AERIAL APPLICATORS INC
HASHBARGER AERIAL SPRAYING INC
NEIDERT, MELVIN E
AG AVIATION SERVICE INC
BEAR FLYING SERVICE INC
SCHLOTMAN, MARK G
FENDER, DARRELL
HAMPTON, BUSTER
WHEELER RIDGE AVIATION INC
HARKSEN, REYNOLD L
WHITTEN FLYING SERVICE
ARMSTRONG, RUSSELL AND HAWK, DANNY
WOOD FLYING INC
HARRIS, RICHARD MCKINLEY
YAGGIE, DAVID A
A AND C FLYING SERVICE INC
CONNER FLYING SERVICE INC
HARTMAN, DAVE R
MIDWEST SPRAY SERVICE OF IOWA LLC
HAWK AG AVIATION INC
MIKE'S AIR SERVICE INC
HAYNES FLYING SERVICE LLC
MILHON AIR INC
HEIGLE, JOSHUA R
MINK, RANDY T
AERO SPRAYING SERVICE INC
MOAD AVIATION INC
ASSOCIATED AERIAL APPLICATORS INC
MOORE, HENRY E JR
A-T AG SERVICES LLC
MOSES LAKE WARDEN AIR SVC
HILL AVIATION INC
BOAIR INC
HILL, CARL LEE
NORD AVIATION INC
HINK, RONALD
NORTHEAST AG FLYERS INC
HINKLE AVIATION
BOENING BROS DUSTING AND SPRAYING SERVICE
HOFER, BRUCE L
ORWICK, BRYCE
HOLLOWAY AIR SERVICE INC
OUSLEY, FRANK
HOPKINS, BILLY E
PACIFIC VALLEY AVIATION INC
HOUSTON CROP SERVICE INC
PARISH OF ST BERNARD
AUGUSTIN, DON M
AGLAND AIR INC
HOWE BROTHERS ENTERPRISES INC
PETERSBURG FLYING SERVICE LLC
HOXIE SPRAYERS INC
PHILIPP, DEAN
HUEY, JACK A AND WILLIAMS, BOB G
PINE RIDGE AIR SPRAY
HUNTER FLYING SERVICE LLC
BORNEMEIER AERIAL SPRAYING INC
HUTCHERSON FLYING INC
PONTIAC FLYING SERVICE
HUTTOS FLYING SERVICE LLC
PREFERRED AG AVIATION LLC
HYBERTSON, H L
PRO-AIR LLC
AERO-SPRAY INC
PRODUCERS FLYING INC
INDEPENDENT DUSTING SERVICE INC
QUALITY AERIAL APPLICATORS INC
INGALLS AERIAL SPRAYERS INC
QUINN AVIATION INC
INLAND CROP DUSTERS INC
4R AVIATION LLC
J AND J AG
BROADVIEW AVIATION LLC
J AND R FLYING SERVICE LLC
REDLINE AVIATION INC
J H S INC
REED, JOHN A
JAMESON, JACK D
BRUCES FLYING SERVICE INC
AVIATION SERVICES INC
RICE AG SERVICE INC
JENNEN, RICHARD J II
RICELAND AVIATION INC
JENSEN AVIATION LLC
BULLOCK, BILLY P
JENSEN, DENNIS
RODGERS AIR SERVICE
AZEVADO, TIM
ROGGE, EMIL S
JOHNSON, CORY AND TRAMPAS
C AND C FLYING SERVICE INC
JOHNSON, DONALD MACK
RYAN, WALTER P AND THARP, ROBERT E
JOHNSONS AERO AG INC
SANDLINE SERVICES LLC
JOHNSTON, BLAKE
CADY, NEIL J
JONES, JAMES M JR
SCHUCK, JON D
B AND W AERIAL SPRAY INC
SCOTT COUNTY SPRAYING SERVICE INC
JTD L L C
CAMPBELL AVIATION INC
K L CORP
SHAW, RICHARD E
KAFER-STONE APPLICATOR SERVICE INC
SHEPPARD, DAVID
KAZS FLYING SERVICE LTD
SHICKLEY AIR SERVICE INC
KELLER, DONALD J
BAKER COUNTY AVIATION INC
WHITLOCK, DENNIS
AG AIR FLYING SERVICE INC
WILLIAMS, FREDDY L
EMRICH AERIAL SPRAYING LLC
DOYLE, THOMAS E
KETTLEY FARMS AERIAL APPLICATION LLC
YAGGIE, ALLEN
KEVIN KINGSLEY LLC
DAVID GLOSUP INC
KIEFFER, WILLIAM ALBERT
PRO-AG SERVICE INC
KILLAM, RODNEY A
DAVIS AGRICULTURE INC
KIMMEL AVIATION INC
PUTZ AERO INC
KIMMEL, MARK
DAWN PATROL AVIATION INC
BALDWIN, JOHN B
R AND R SPRAYING INC
406 AG LLC
RAL AVIATION
AIR INC
RANDY A WILSON FARMS
KLAMAR SPRAYING INC
GEORGESON, JAMES E
BARBER FLYING SERVICE LLC
BROWN AVIATION INC
ABILENE FLYING SERVICE INC
COPPAGE FARM SERVICES INC
ERHART AERIAL SPRAYING INC
RETTERATH, MARK
BARKER FARM SERVICES INC
RICE FLYING SERVICE
BARLOW, KIRK A
BRUTON AERIAL SPRAYING INC
KNUTSON, EUGENE W
RITTINER GROUP L L C
KOCH AG SERVICE INC
ROBINSON, RONALD G
KOCH OPERATIONS INC
GOFF, JAMES R
KOINZAN FLYING SERVICE INC
ROOT SPRAYING SERVICE INC
KOLB, DELBERT
BURKETT, JOE
KRACKE, CURTIS DEAN
BUTLER AIRCRAFT CO
KRAFT AG AVIATION INC
RUSTIN, CODY W
KRAJCIRIK, JOSEPH ROBERT
S AND D SPRAYING SERVICE INC
KRATZ AERIAL AG SERVICE INC
SALEM SPRAYING SERVICE
KROGMAN AERIAL SPRAYING INC
DENNIS FLYING SERVICE INC
KRUSE, PAUL
SCHINDLER, KELLY
BARTA, DANIEL W
SCHOEPFLIN, DALE E
ESTES, RICHARD JR
GRAYS FLYING SERVICE INC
CUSTOM AIR SERVICE LLC
SECOND MILE FLYING SERVICE LLC
KURTZ, GAROLD D
SENEASHA AIR SERVICE INC
KUTHER, KEN J
SHENANDOAH AG FLIGHT LLC
BARTON AERO INC
GRIFFITH, HAROLD LUTHER
KYLLO, JEFFREY
SIEVERT AG AIR LLC
L AND L FLYING INC
SKY AVIATION
ABOVE STANDARD FLYING SERVICE LLC
SKYRAIDER INC
EVANSON, MARK
CARLSON, J SAMUEL
BASKIN, GARY O
GUST, DOUGLAS J
LAKE WASHINGTON FLYING SERVICE INC
GUY, JOE
BAUER, CHARLES
AGRIFLITE WEST INC
CUSTOM APPLICATORS LLC
SOUTHER FIELD AVIATION INC
D AND C FLYING SERVICE INC
H AND W AG SERVICES INC
LANE, CHRISTOPHER ASHLEY
SPOT AVIATION LLC
LANGELAND, CARROL D
SPRINGLAKE FARM CHEMICAL
LARRY BOYER LAND AND CATTLE
STATE OF MARYLAND DEPARTMENT OF AGRICULTURE
LARRY LESTER FLYING SERVICE INC
STERLING, JOHN A
EVERIDGE, RON J JR
STOHR, BEUFORD G
LARSON, REX W
STOUT, RALPH E
EZ AVIATION AERIAL APPLICATION LLC
STRICK'S AIR CARE INC
D AND F FLYING SERVICE
MURPHREE, RANDALL C
STURDIVANT BROTHERS FLYING SVC
MYERS FLYING SERVICE INC
A AND C AG AVIATION INC
MYERS, GARY LEON
AGRIJET INC
BLUE SKY SPRAY SERVICE LLC
SUPER SPRAY SERVICES INC
BMA INC
SUTTON, BRIAN
NELSON FLYERS INC
SWING WING INC
NELSON, SIDNEY N
HARMON, JAY HOUSTON
NELSON, TERRY W
DOLAND AERIAL SPRAYING
BNKL CORPORATION
TAILWINDS AIR INC
DANNYS AIR-AGRI SERVICE INC
TALLAFORE AGRICULTURAL AVIATION INC
BOB DONNER ENTERPRISES LLC
CAUSEY, KEVIN
NEWBY, PAUL G
TAYLOR, CHARLES THOMAS
NEWKIRK, THOMAS RAY
TAYLOR, JAMES E
FORD FLYING SERVICE INC
T-C AERIAL LLC
NICK'S FLYING SERVICE INC
HART FLYING SERVICE INC
NICKS FLYING SERVICE INC
TEXAS AIR CARGO INC
NIX FLYING LLC
THAGGARD AVIATION LLC
NOCO INC
CENTRAL AG LLC
AG-AIR L L C
THOMAS AG AERIAL INC
NOLEN AG SERVICES INC
THOMAS FLYING SERVICE LLC
NORTH STAR AVIATION OF HALLOCK
COSTA, JAMES JOSEPH
FOSHEE SPRAYING SERVICE INC
THOMPSON AERIAL SERVICE INC
NORTHERN AG SERVICE INC
HARTWIG, LONNIE DEAN
NORTHERN AIR AND AG LLC
THOMPSON, MARK
NOR-WES INC
ARROW AVIATION INC
NUNN, STANLEY E
CENTRAL FARMERS CO-OP
O AND K AVIATION INC
TIDWELL SPRAYERS INC
OBIE, EDGAR L
1LOWFLYER INC
BODE, CLAY
TIMMONS, CHARLES COOPER
AG-CONCEPTS INC
CENTRAL PLANES AVIATION INC
OHIO VALLEY AIRCRAFT INC
TLC FLYING INC
FOSTER, JAMES L
AIR AG SERVICE INC
AERINOVA AERIAL LLC
TOP HAND INC
OLD RIVER APPLICATORS LLC
TOP SHOT AG SERVICES LLC
OLD RIVER CROP DUSTING INC
TOWE, LANNIE K
O'LEARY AVIATION INC
DOUBLE D FLYING SERVICE INC
BOETTCHER AERIAL COMPANY
TRESTER, BOYD H
OLSEN SPRAYING SERVICE INC
TRI-AIR FARMS LLC
OLSON AERIAL LLC
HEARTLAND AERIAL SPRAYERS LLC
OMEGA AIR SERVICE LLC
AERIAL CROP CARE LLC
ORANGE COUNTY MOSQUITO CONTROL DISTRICT
AIR ASSAULT AGRICULTURAL AVIATION LLC
FOUR STATES SKY AG LLC
CHISM, DONALD RAY
FOWLER, BRADLEY
AERIAL PRECISION LLC
OSCAR AVIATION LLC
TRUMP, ROGER L
FOWLER, TIMOTHY LEE
TUCKERMAN FLYING SERVICE INC
OVER AND UNDER FLYING SERVICE
COTTONWING AIR LLC
OWEN FLYING SERVICE INC
TWIN CITIES AVIATION LLC
FRANKIE'S AERIAL APPLICATION, LLC
AIR CARE FLYING SERVICE INC
FREE AIR AVIATION LLC
CHUCK'S FLYING SERVICE LLC
PADDOCK AIRWAYS INC
VALBURG AERIAL SPRAYING INC
FREI, CHAD M
VALLEY AG AERIAL SERVICES
PAGE AERIAL SERVICE

HEADWATERS FLYING SERVICE LLC
NEWBERG SKY SPRAY
BRIGNAC FLYING SERVICE LLC
NOE AVIATION LLC
SHERMAN, RICHARD E
3 C'S FLYING LLC
BURGHDUFF AVIATION LLC
BELL AG SERVICE INC
SIMPSON, DON
O'CONNER, DALLAS
SKY TECH INC
FLITE LEVEL ZERO INC
SLIKKER FLYING SERVICE INC
BENNACK FLYING SERVICE INC
HENDRICKSON, GARY
FLYNTS CROP DUSTING
SOUTHEASTERN AERIAL CROP SERVICE INC
PASSMORE, STEPHEN B
CARMICHAEL, MATTHEW G
PENROSE INC
SUN VALLEY DUSTING CO
PERRYTON AVIATION INC
CAT AGRI AVIATION INC
PIONEER FLYING SERVICE INC
CAVANAUGH FLYING SERVICE INC
AIR ENTERPRISES INC
TANNER, JACK
BENSON AIR AG INC
HOWARD FLYING SERVICE INC
PLANTERS AIR SERVICE INC
TBM INC
FRONTIER AG INC
ALTENDORF, RICHARD C
PLU'S FLYING SERVICE INC
AERO SPRAY SERVICES INC
BIGHORN AIRWAYS INC
THRASH AVIATION INC
PRECISION AIR OF FRANKLIN LLC
TIDWELL FLYING SERVICE INC
G N DIBBLE INC
AMERICAN SPRAYERS INC
GARDNER, MAUREICE
JEFFERSON COUNTY MOSQUITO CONTROL
ADAMS FLYING SERVICE INC
JERRYS LOW LEVEL SPRAYING INC
GEORGE, WILLIAM T
TRADE WIND AG SERVICE INC
GIBSON FLYING SERVICE
CHESTER SPRAY INC
A N F AIR SERVICE INC
TRIPLE J FLYING SERVICE INC
R AND R FLIGHT SERVICE INC
JORDAN AIR INC
GOULD, PAUL M
KEETER, JERRY M
RANSPOT, RICHARD PAT
ARNT AERIAL APPLICATION
BLAIRS FLYING SERVICE INC
KENT JUDE COCO
GRAY, RONALD W
CROP DUSTERS LLC
AIR SPRAYERS INC
WALLACE AVIATION INC
GROULEFF AVIATION INC
WEHRMAN, JAMES
REED, JOHN R
WELLS AIR SERVICE INC
GROWERS AIR SERVICE LLC
WERTH, LANCE
RICE COUNTY AERIAL SPRAYERS INC
CROP JET AVIATION LLC
RICHARD FLYING SERVICE INC
CROPLAND AIR SERVICE INC
GUNIA, MICHEL L

CAPROCK SPRAYING INC
KEN GRUBBS AERO INC
SIOUX AIR INC
KEO AG SERVICE INC
SKY-TRACTORS INC
10 TANKER AIR CARRIER LLC
SLATER SPRAYING SERVICE INC
KING, RICHARD V SR AND RICHARD V JR
SMITH, GENTRY SELLERS
KINGDOM FIRST SEED LLC
SNYDER SPRAYING SERVICE INC
KIRKS AVIATION INC
CAROLINA CROP CARE LLC
KLONDIKE AVIATION LLC
SOUTHERN AIRE INC
KNOX, TOM F
SPRAY PLAINS INC
KOHLHAAS, JEROME R
CAROLS FLYING SERVICE INC
BARNEY, STEVEN K
STAVA, ROBERT D
KUBECKA, DONALD
STEIER, TIMOTHY A
KUBIN AERIAL INC
STEVENSON, RICHARD VON
LADELLES SPRAYING SERVICE
STORM FLYING SERVICE LLC
LAMBERT, RICHARD DALE
STOTT AERIAL SPRAY INC
LANE AVIATION INC
STROHL AVIATION LLC
LARSEN, WAYNE
CARROLL FLYING SERVICE INC
BAUGHMAN AIR SERVICE INC
SUNNYSIDE AERO INC
LARSON, LYNN R
SYRACUSE FLYING SERVICE INC
LAST PASS AVIATION INC
TATRO, CHRISTOPHER A.
LAUDERDALE AERIAL SPRAYING LLC
TERRILL, GUY J
LEE, MICHAEL E
THOMAS R SUMMERSILL INC
LEHRKAMP, DARREL A
4-STATE SPRAY SERVICE LLC
LELEUX FLYING SERVICE INC
TIM NEWTON FLYING SERVICE LLC
LINDEMANN AVIATION LLC
TODD'S AERIAL SPRAYING, LLC
LISSIE FLYING SERVICE INC
TONYS AERIAL SPRAYING INC
LISTER, JAMES RICHARD JR
CHARLES TROWER AVIATION INC
LOCKER INC
TRI-COUNTY AG LLC
LONDE AIR SERVICE INC
TRINKLE, MARK
BEILKE, CHRIS
TRITES FLYING SERVICE INC
LUNGRIN, CHARLES V
TUNICA AIR INC
AG CARE BY AIR INC
TYREE AG INC
BENOIT FLYING SERVICE INC
VALLEY CROP DUSTERS INC
M AND D AERIAL LLC
VANN, D CARROLL
AG INC
VISSER AG INC
M J DICKENSON AIRPLANE SPRAYING CO
WALHALLA AVIATION LLC
MAC FLYING SERVICES INC
WALLACE FLYING SERVICE INC
MALLARD, ALMA D

SUGGS, ROYCE LEE
LEADING EDGE AERIAL SPRAYING LLC
COODY AIR-AG INC
BEAR BAYOU AG SERVICE INC
SWANCUTT AVIATION INC
LEE, RONALD C
SYVERSON, RON
LEESBURG SPRAYING SERVICE INC
AERIAL APPLICATIONS COMPANY INC
LEGGETT, JEFFREY LYNN
HARRIS SPRAYING INC
LEJEUNE AERIAL APPLICATIONS LLC
AERIAL APPLICATIONS LLC
FARM AIR INC
TETON RIVER FLYING SERVICE INC
LEPANTO CROP SERVICE INC
THIEF RIVER AVIATION INC
LESCO AVIATION INC
THOMAS FARMS FLYING SERVICE INC
BEARD, JUNIOR GAYLE
THOMAS, JOHN J.
LEWIS AG AVIATION INC
THOMPSON FLYING SERVICE LLC
ACE AERO LLC
THREE RIVERS FLYING SERVICE CO INC
LEWIS FLYING SERVICE OF BASILE INC
TIGER AVIATION LLC
LIGHT AIR, INC. OF BEECH GROVE ARKANSAS
TIMS AG-AVIATION
LINDEMAN INC
HAUSCHILD, BRYAN DEAN
BECKS SPRAY SERVICE
HAY, GLEN R AND ROBERT J
AIRWORKS LLC
TOWNSEND AVIATION INC
BEERY, MILO
TRI STATE AERIAL LTD
LINNEBUR, GENE
HEARTLAND AVIATION INC
LIPSCOMB, G GERALD
CHISENHALL AGRICULTURE SERVICES INC
AIR-WORTHY INC
TRONSTAD, JORN
D AND M FLYING SERVICE INC
HEIMGARTNER, MARK
ALANIZ, PEDRO
CHOCTAW FLYING SERVICE INC
LOFTON, CHAD
VAL-AIR AVIATION
LOHSE, WILLIAM F
VALLEY AG AIR LLC
ALBION AERIAL SPRAYERS INC
VANHOUTEN FLYING SERVICE INC
D AND S AERIAL LLC
CJ AIR LLC
AG AVIATORS INC
WAKEFIELD FLIGHT SERVICE INC
LOUP CITY AIR SERVICE
WARNER AG AIR L C
LOVE AERO LLC
WAUKENA FLYING SERVICE INC
BELL FLYING INC
HELLE, RANDY
LOW LEVEL DUSTING CO INC
CLEAR SKIES AVIATION LLC
BELLAMY AERIAL SPRAYING INC
WEST TENNESSEE AIR SERVICE LLC
BENGER AERO SPRAYING INC
HI PLAINS AG SERVICE INC
LOWRY INC
AT HOLDING-KRAUSE LLC
LOWRY'S FLYING SERVICE INC
WHITTINGTON, JOHN H JR
D C AG INC

VALLEY AIR APPLICATORS INC
BOLING AVIATION SERVICES LLC
VALLEY FLYING SERVICE INC
PALMER, NOEL S
VAUGHNS FLYING SERVICE INC
PALOUSE AG AVIATION LLC
VERWOLF, PHIL A
PANIERE, ERIC WAYNE
VINE, CLAYTON
FRENCH, DANIEL T
WA LU AVIATION INC
PATCHETT, LAWRENCE K
CLARK, MICHAEL GORDON
FREPPON, JOHN
WALTON AGWINGS INC
PATTERSON, DALE
WARREN AG AVIATION INC
PATTON CUSTOM FERTILIZER
WATSON AG AVIATION LLC
PAUL FOSHEE DUSTING CO
WAVRA, MARK F
PAWNEE AIR CARE INC
WEATHERLY, WAYNE
PENCE, DALE E
WEBB, JOHN T
FREY, JERRY P
ASHLEY AIR SERVICE L L C
DARTER AVIATION SERVICES LLC
WELSTAD, BLAINE L
PETERSON, DWIGHT W
WEST FLYING SERVICE INC
AIR REPAIR INC
DOUGLAS ODOM CROP SPRAYING INC
PETERSON, LUCAS
HERRON, BILLY R
PFISTERS FARM AVIATION INC
WHIRLWIND AVIATION INC
PFS INC
WHITE CASTLE FERTILIZER CO-OP INC
FROST, JACKIE R
HILDE, RICHARD L
PIETRON SPRAYING INC
HILDEBRANDT, KENNETH M
FUSSELL, LEON J
WIEBE, TIMMY KLASSEN
PINECLIFF AERIAL INC
WILCOX FLYING SERVICE LLC
BOOTHEEL AG AIR SERVICES LLC
COLE FLYING SERVICE
BORDER AVIATION L L P
WILSON FLYING SERVICE INC
PLANTATION FLYERS LLC
WINDY'S FLYING SERVICE LLC
DAVEAIR LLC
WINFIELD FLYING SERVICE LLC
PLANTERS FLYING SERVICE INC
WISCHER AVIATION INC
PLAQUEMINES PARISH GOVERNMENT
WOLENETZ, BYRON F
AG-LAND AVIATION INC
COMPTON, RALPH
PLUHAR, DENNIS A
HILLEGEIST AVIATION
BOYER, JOHN L
WYATT'S FLYING SERVICE
G AND S CROPDUSTING INC
DRAKE FLYING SERVICE INC
AERO APPLICATIONS INC
HIRSCH, ALVIN
POWERS, ELBIE
ZACK'S FLYING SERVICE INC
PRECISION AERIAL AG LLC
ZUBER, GARY D
PRECISION AG INC
HITCH AVIATION INC

Appendix C. ARP/ACP History

FY89: Original ARP offered at $12K/year to commit pilots to 14 CYOS following expiration of their 7-year UPT ADSC

FY96: Helicopter pilots added to ARP eligibility

FY98: NDAA funds $22K bonus with variable contract length/amount; FY97 eligibles permitted to renegotiate contracts. Take rate-28 percent

FY99: ARP offered to prior-service (i.e., late-rated) officers. Take rate-42 percent

FY00: Increased max annual payment to $25K with 50 percent up-front option capped at $100K. UPT ADSC increased to 10 years, ABMs added to rated force. Take rate-32 percent

FY01: Capped 50 percent up-front option at $150K. Airline hiring slowed in the post-9/11 environment; stop loss and rated recall program initiated to meet rated demands in support of GWOT. Take rate-30 percent

FY03: Program restructured to target specific AFSCs (pilot, nav, ABM). Retirement-eligible nav and initial-eligible ABMs offered ARP for the first time ($10-15K/year depending on contract length); pilots offered ARP in variable lengths to 25 YAS. Take rate-65 percent

FY04: Lowered the max agreement to 20 YAS for pilots, and added navigators w/9 YAS. The low production years of the 90s (coupled with increased airline hiring) led to peak spending of $218M in FY04 to meet OEF/OIF requirements. Take rate 76 percent

FY05: Pilots offered a 5-year ($125K/year) agreement with 50 percent up-front option; continued navigator and ABM eligibility ($15K/year) at 9 and 6 YAS respectively. Take rate-65 percent

FY06: Eliminated navigator ARP and pilot's 50 percent up-front option; renewed ABM eligibility ($15K/year for 5 years). Take rate-66 percent

FY10: Due to massive expansion in the RPA career field to 65 CAPs, ARP offered to CSOs who cross-trained as RPA pilots ($15-25K/year with 3-5 year contract lengths). Take rate-77 percent

FY11: Eliminated ABM ARP; limited eligibility to pilots (including RPA) and CSOs trained as RPA pilots (12U). Uncommitted 12Us offered a 3, 4, or 5-year agreement at $15K/year. Take rate-70 percent

FY12: Program targeted low inventory fighter pilot and RPA numbers with a 50 percent upfront option; fighter CSOs offered 5-year ARP option for $15K/year, all other CSOs and ABMs excluded. Uncommitted pilots offered 3-5 year contract at $15K/year. Take rate-67 percent

FY13: Program, again, targeted low fighter pilot inventory w/"To 20 YAS" and 50 percent up front option; RPA pilots offered 50 percent up front on 5-yr offering. Fighter CSOs offered 5-year ARP option for $15K/year. RPA CSOs and uncommitted pilots offered 3-5 year contract at $15K/year. All other CSOs and ABMs excluded. Take rate-67 percent

---

Appendix D. Regional Airline Contract Negotiation Example

The following article describes the contract negotiations between American Airlines and Envoy, the 3rd largest regional.

The head of Envoy Air's pilot union told members Friday that the latest effort to reach a deal with parent American Airlines Group has ended without an agreement.

The breakdown likely means that 40 larger regional jets on order will likely go to another carrier unless management relents.

In a statement, American spokesperson Casey Norton did not address what will happen to the 76-seat jets that Envoy would have gotten.

"We're evaluating our options for a cost-competitive regional carrier to operate the remaining 40 E175s[182]. We also have the option to add future E175 deliveries to our Compass agreement announced earlier this summer," Norton said.

He called Envoy "a very important part of American Airlines Group (AAG) and a significant provider of regional feed for American Airlines".

"American would like to place some of its large regional aircraft with Envoy, but the economics of Envoy's current contract are not competitive," Norton said. "There were discussions with Envoy ALPA to see what could be done to remedy this, but these talks did not lead to an agreement."

In a letter to Air Line Pilots Association (ALPA) members, Master Executive Council[183] chairperson Bill Sprague said American came to the union several weeks earlier "and expressed a desire to re-engage in discussions to achieve a structure that AAG believes is necessary to ensure the competitive nature of the regional feed industry".

ALPA did not accept American's proposal, and American on Wednesday told the union finally that it did not accept ALPA's proposal.

"Their stated intent is to continue seeking lower feed costs at other Fee for Departure carriers, as they did with Compass," Sprague said in his message.

---

[182] Newer, larger regional jets

[183] Group that represents the regional for ALPA and negotiates with the major Airline

He was referring to Compass Airlines, which will fly 20 of the 60 Embraer 175 jets that American has on firm order.

Management had promised the 60 jets to Envoy in early 2014 if pilots would accept concessions in a new contract. Union members in late March rejected the proposal, with 70 percent opposed.

American subsequently announced in June that Compass would operate 20 of those jets beginning in first quarter 2015.

In the latest talks, American said that Envoy – formerly known as American Eagle Airlines and which still flies under the American Eagle brand – could get the 40 remaining jets if it accepted conditions spelled out by American.

The previous proposal promised that American Airlines Group would keep at least 170 jets in the Envoy fleet. The revised proposal would have reduced that to 150 since Compass had gotten 20 airplanes that were in the proposed 170-aircraft fleet.

American issued a statement saying that the ALPA MEC at another of its regional affiliates, Piedmont Airlines, had "voiced unanimous support" for a tentative agreement. Piedmont's pilots will now vote that deal.

"The TA provides a clear path for career advancement and positions Piedmont for future success in a highly competitive industry," American said. "We appreciate the constructive discussions with Piedmont ALPA MEC and thank them for giving Piedmont pilots the opportunity to vote on their future."

American, which merged Dec. 9 with US Airways, owns Envoy and two US Airways Express regional carriers, Piedmont and PSA Airlines.

Last September, PSA pilots, also members of ALPA, voted for a new contract that management had required in exchange for that carrier getting 30 new Bombardier jets, also with 76 seats.[184]

[184] http://aviationblog.dallasnews.com/tag/envoy-air/

Appendix E. Regressions

For the following regressions, X Variable 1 is the primary relationship, X Variable 2 is a force shaping dummy variable.

Figure F.1. USAF Separations and Retirements versus MAH

Total USAF Separations and Retirements with Force Shaping Control

Regression Statistics	
Multiple R	0.955027919
R Square	0.912078325
Adjusted R Square	0.901088116
Standard Error	0.009579688
Observations	19

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	0.01523207	0.007616035	82.99007765	3.57082E-09
Residual	16	0.001468327	9.17704E-05		
Total	18	0.016700397			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 75.0%*	*Upper 75.0%*
Intercept	0.026369733	0.004031575	6.540801395	6.79906E-06	0.017823175	0.034916291	0.021557301	0.031182166
X Variable 1	1.63747E-05	1.39258E-06	11.75851212	2.76056E-09	1.34226E-05	1.93268E-05	1.47124E-05	1.8037E-05
X Variable 2	0.033833627	0.00602974	5.611125062	3.90194E-05	0.021051149	0.046616106	0.026636014	0.04103124

Figure F.2. USAF Total Losses versus MAH

Total USAF Losses with Force Shaping Control

Regression Statistics	
Multiple R	0.943200341
R Square	0.889626883
Adjusted R Square	0.875830243
Standard Error	0.011083049
Observations	19

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	0.015841018	0.007920509	64.4814176	2.20245E-08
Residual	16	0.001965344	0.000122834		
Total	18	0.017806361			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 75.0%*	*Upper 75.0%*
Intercept	0.042795456	0.004664259	9.175188906	8.97366E-08	0.032907669	0.052683243	0.037227798	0.048363113
X Variable 1	1.61677E-05	1.61112E-06	10.03507121	2.6162E-08	1.27523E-05	1.95832E-05	1.42446E-05	1.80909E-05
X Variable 2	0.039144285	0.006976	5.61127926	3.90077E-05	0.024355825	0.053932744	0.030817135	0.047471434

Figure F.3. USAF Separations versus MAH

Total USAF Separations with Force Shaping Control

Regression Statistics	
Multiple R	0.913799409
R Square	0.83502936
Adjusted R Square	0.81440803
Standard Error	0.011029356
Observations	19

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	0.009851796	0.004925898	40.49347742	5.48597E-07
Residual	16	0.001946347	0.000121647		
Total	18	0.011798143			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 75.0%*	*Upper 75.0%*
Intercept	0.005470311	0.004641663	1.178524023	0.255818342	-0.004369574	0.015310196	-7.03741E-05	0.011010996
X Variable 1	1.40192E-05	1.60332E-06	8.743881969	1.71765E-07	1.06203E-05	1.74181E-05	1.21054E-05	1.59331E-05
X Variable 2	0.016571658	0.006942204	2.38708868	0.029671452	0.001854842	0.031288473	0.008284849	0.024858466

Figure F.5. USN Total Losses versus MAH

Total USN Fixed-Wing Losses

Regression Statistics	
Multiple R	0.892285265
R Square	0.796172993
Adjusted R Squar	0.781613921
Standard Error	0.012593776
Observations	16

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.008673326	0.008673326	54.68569689	3.37858E-06
Residual	14	0.002220445	0.000158603		
Total	15	0.010893771			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 90.0%*	*Upper 90.0%*
Intercept	0.063750563	0.005140585	12.4014225	6.12411E-09	0.052725105	0.074776021	0.054696399	0.072804727
X Variable 1	1.40157E-05	1.8953E-06	7.394977815	3.37858E-06	9.95067E-06	1.80807E-05	1.06775E-05	1.73539E-05

Figure F.6. ANG Total Losses versus MAH

Total ANG Loss with Force Shaping Control

Regression Statistics	
Multiple R	0.798908502
R Square	0.638254794
Adjusted R Square	0.610428239
Standard Error	0.012651351
Observations	15

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.003671203	0.003671203	22.93689641	0.000353595
Residual	13	0.002080737	0.000160057		
Total	14	0.00575194			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 75.0%*	*Upper 75.0%*
Intercept	0.038211097	0.005491897	6.957723405	9.95093E-06	0.026346576	0.050075618	0.03159805	0.044824143
X Variable 1	9.21721E-06	1.92456E-06	4.789248	0.000353595	5.05944E-06	1.3375E-05	6.89975E-06	1.15347E-05

Figure F.7. AFR Total Losses versus MAH

Total AFR Loss with Force Shaping Control

Regression Statistics	
Multiple R	0.769942225
R Square	0.59281103
Adjusted R Square	0.561488802
Standard Error	0.017995674
Observations	15

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.006129144	0.006129144	18.92620862	0.000786377
Residual	13	0.004209976	0.000323844		
Total	14	0.01033912			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 75.0%*	*Upper 75.0%*
Intercept	0.048159313	0.007811844	6.164909788	3.40518E-05	0.03128285	0.065035776	0.03875271	0.057565915
X Variable 1	1.19095E-05	2.73756E-06	4.350426257	0.000786377	5.99541E-06	1.78237E-05	8.61312E-06	1.5206E-05

Figure F.8. ANG Affiliations within one year of Separating

ANG Affiliations within one year of Separating

Regression Statistics	
Multiple R	0.960185204
R Square	0.921955626
Adjusted R Squ	0.910806429
Standard Error	19.51196696
Observations	17

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	62964.90521	31482.45261	82.69256332	1.76356E-08
Residual	14	5330.035964	380.7168546		
Total	16	68294.94118			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	17.51590071	8.955757809	1.955825636	0.070742972	-1.692289417	36.72409084	-1.692289417	36.72409084
X Variable 1	0.185753868	0.014444704	12.85965239	3.82947E-09	0.15477306	0.216734676	0.15477306	0.216734676
X Variable 2	-25.89208425	14.84471495	-1.744195448	0.103029493	-57.73083126	5.94666277	-57.73083126	5.94666277

Figure F.9. AFR Affiliations within one year of Separating

AFR Affiliations within one year of Separating

Regression Statistics	
Multiple R	0.972847289
R Square	0.946431847
Adjusted R Squ	0.938779254
Standard Error	35.2310357
Observations	17

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	307016.3671	153508.1836	123.6746563	1.26575E-09
Residual	14	17377.16227	1241.225876		
Total	16	324393.5294			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-3.664590951	16.17062102	-0.226620298	0.823994504	-38.34712365	31.01794175	-38.34712365	31.01794175
X Variable 1	0.410062279	0.026081526	15.72232707	2.72739E-10	0.35412297	0.466001588	0.35412297	0.466001588
X Variable 2	-71.5916067	26.8037909	-2.670950798	0.018265925	-129.0800206	-14.10319279	-129.0800206	-14.10319279

Figure F.10. New ATP Certificates vs MAH 1994-2011

New ATP Certificates vs MAH 1994-2011

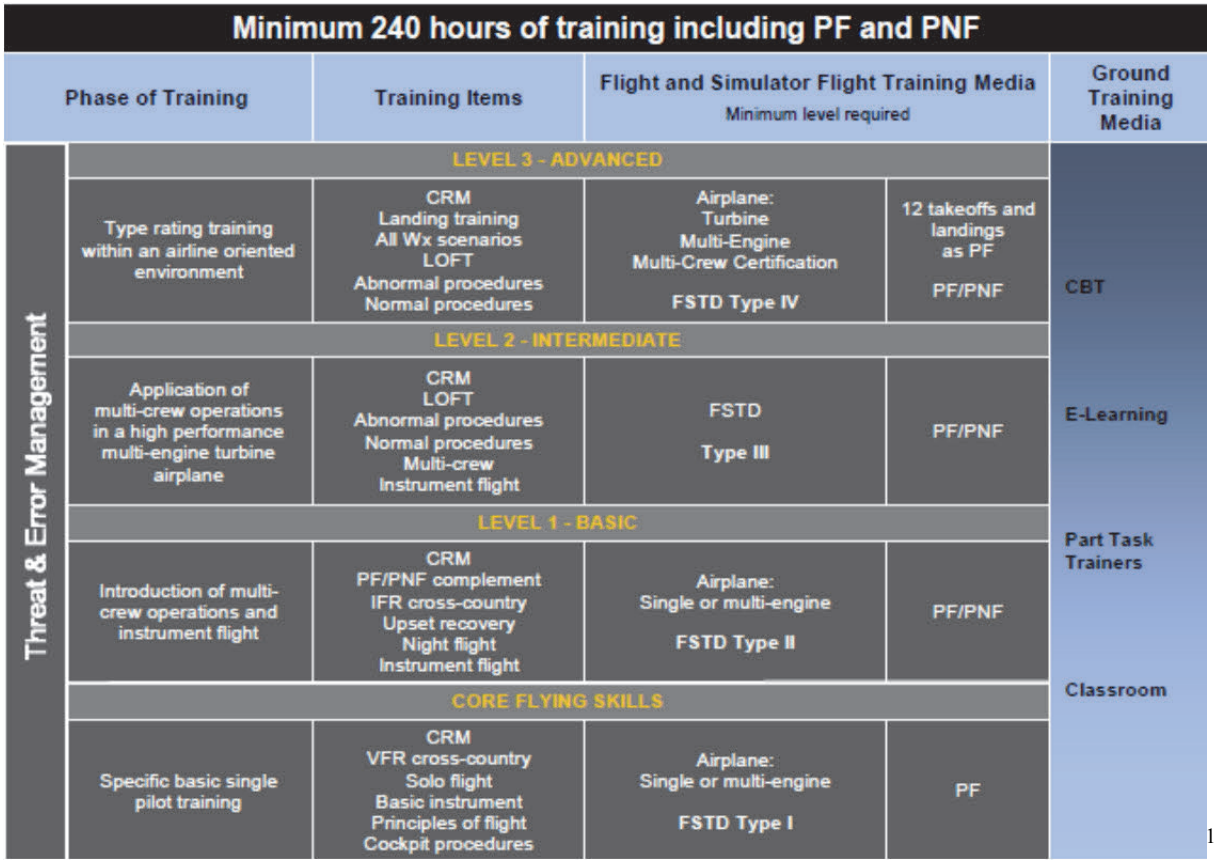
Regression Statistics	
Multiple R	0.874814696
R Square	0.765300751
Adjusted R Squar	0.750632048
Standard Error	745.2174943
Observations	18

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	28973869.96	28973869.96	52.17235292	2.033E-06
Residual	16	8885585.821	555349.1138		
Total	17	37859455.78			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	3554.284329	322.9639674	11.00520395	7.13177E-09	2869.631303	4238.937355	2869.631303	4238.937355
X Variable 1	0.816495276	0.113040342	7.223043189	2.033E-06	0.576860455	1.056130097	0.576860455	1.056130097

Appendix F. MPL Training Scheme



[185]

CRM - crew resource management
LOFT - line-oriented flight training
IFR - instrument flight rules
FSTD - flight-training device (simulator). Types I through IV represent different levels of movement and cockpit fidelity, with Type IV being the highest.
PF - pilot flying (same as PIC)
PNF - pilot not flying (same as SIC)
CBT - computer-based training

[185] https://www.hawaii.edu/offices/eaur/govrel/briefings/2008/2008_08_21_aerospace_pedersen.pdf

Appendix G. Pay Comparisons

	Baseline		Capt @ Regional 1 yr earlier		Increase Regional Pay 25%		Capt @ Regional 2 yrs earlier		Increase Regional Pay 50%	
Year	Pay	Cumulative	Pay	Cumulative	Pay	Cumulative	Pay	Cumulative	Pay	Cumulative
1	22582	22582	22582	22582	28227	28227	22582	22582	33873	33873
2	33804	56386	33804	56386	42255	70483	33804	56386	50706	84579
3	36560	92946	36560	92946	45700	116182	36560	92946	54839	139419
4	38010	130956	38010	130956	47512	163695	38010	130956	57015	196434
5	38675	169631	38675	169631	48344	212038	38675	169631	58012	254446
6	39382	209012	39382	209012	49227	261266	58834	228464	59073	313519
7	40129	249141	58834	267846	50161	311427	61362	289827	60193	373712
8	58834	307975	61362	329209	73542	384969	58010	347837	88251	461962
9	61362	369337	58010	387219	76703	461672	96898	444735	92043	554006
10	58010	427348	96898	484117	58010	519682	111829	556564	58010	612016
11	96898	524245	111829	595946	96898	616580	117889	674453	96898	708914
12	111829	636074	117889	713835	111829	728409	125031	799484	111829	820743
13	117889	753964	125031	838866	117889	846298	129254	928738	117889	938632
14	125031	878995	129254	968120	125031	971329	134559	1063297	125031	1063663
15	129254	1008248	134559	1102679	129254	1100583	138204	1201501	129254	1192917
16	134559	1142807	138204	1240883	134559	1235142	142820	1344322	134559	1327476
17	138204	1281012	142820	1383704	138204	1373346	161044	1505366	138204	1465680
18	142820	1423832	161044	1544748	142820	1516167	163857	1669223	142820	1608501
19	161044	1584876	163857	1708605	161044	1677211	170068	1839291	161044	1769545
20	163857	1748734	170068	1878673	163857	1841068	186324	2025615	163857	1933403
21	170068	1918802	186324	2064997	170068	2011136	200712	2226327	170068	2103470
22	186324	2105126	200712	2265709	186324	2197460	200712	2427039	186324	2289794
23	200712	2305838	200712	2466421	200712	2398172	202598	2629637	200712	2490506
24	200712	2506549	202598	2669019	200712	2598884	204952	2834589	200712	2691218
25	202598	2709147	204952	2873971	202598	2801482	204952	3039541	202598	2893816
26	204952	2914100	204952	3078923	204952	3006434	204952	3244494	204952	3098768
27	204952	3119052	204952	3283876	204952	3211386	207649	3452143	204952	3303721
28	204952	3324004	207649	3491525	204952	3416339	210891	3663034	204952	3508673
29	207649	3531654	210891	3702416	207649	3623988	213720	3876754	207649	3716322
30	210891	3742544	213720	3916136	210891	3834879	215432	4092186	210891	3927213
31	213720	3956264	215432	4131568	213720	4048599	217069	4309255	213720	4140933
32	215432	4171697	217069	4348637	215432	4264031	219209	4528464	215432	4356365
33	217069	4388766	219209	4567846	217069	4481100	220781	4749245	217069	4573434
34	219209	4607974	220781	4788627	219209	4700309	220781	4970026	219209	4792643
35	220781	4828755	220781	5009407	220781	4921090	246471	5216497	220781	5013424
36	220781	5049536	246471	5255878	220781	5141871	246471	5462968	220781	5234205
37	246471	5296007	246471	5502350	246471	5388342	247327	5710295	246471	5480676
38	246471	5542478	247327	5749677	246471	5634813	247327	5957622	246471	5727147
39	247327	5789805	247327	5997004	247327	5882140	247327	6204949	247327	5974474
40	247327	6037132	247327	6244331	247327	6129467	247327	6452276	247327	6221801

Regional FO
Regional Captain
Majors FO
Majors Captain

SOURCE:[186]

[186] Salary data (does not include additional pay such as international override or per diem, nor does it include any retirement benefits) for each of the top airlines built from airlinepilotcentral.com and audriesaircraftanalysis.com with the following assumptions:

Majors – United, Delta, American/US Air, FedEx, Southwest, UPS, JetBlue, Alaska. CY14 $, 75hrs/month (pay based on hourly wage), No Interest, No scheduled pay raises factored in.

Regionals – SkyWest, American Eagle/Envoy, ExpressJet, Republic, Endeavor. CY14 $, 80hrs/month (pay based on hourly wage), No Interest, No scheduled pay raises factored in.

References

AFPC/DSYA (1997-2013). Rated Officer Retention Analysis**:** 16.

Berry, T. (2013). Pilot Supply Outlook. Washington, DC, The MITRE Corporation.

Boeing (2014). Current Market Outlook 2014-2033. Seattle, WA**:** 43.

Carey, S. (2014). American Pilots, Management Agree to Keep Talking on a New Labor Deal. Wall Street Journal. Online, ProQuest Newspapers.

Carey, S., et al. (2012). Airlines Face Acute Shortage of Pilots. Wall Street Journal. Washington, DC.

Cleveland, F. (2013). American Eagle Pilot Source Study. AABI Winter Meeting.

Dalonzo, W. J. (1999). A Comprehensive Look at Rated Management in the 90'S and Beyond Air University. Maxwell AFB, AL.

Davis, C. (2012). Pilot and Technician Hiring Forecast. Seattle, WA, The Boeing Company.

Delta (2012). North America Mainline Carrier's Pilot Age Study, Delta Airlines.

Delta (2014). Pilot Attrition. M. McGee**:** 1.

Elliott, M. N., et al. (2004). Modeling the Departure of Military Pilots from the Services. Santa Monica, CA, The RAND Corporation**:** 86.

Expressjet (2014). "2014 Pilot Attrition." 8.

FAA (2011). The Economic Impact of Civil Aviation on the US Economy. USDOT. Washington, DC, Federal Aviation Administration**:** 52.

FAA (2011). "Overview — Title 14 of the Code of Federal Regulations (14 CFR)." 46.

FAA (2012). Methodology for the 2012 General Aviation and Part 135 Activity Survey. Washington, DC, Federal Aviation Administration**:** 21.

FAA (2012). Pilot Certification and Qualification Requirements for Air Carrier Operations Federal Register. Washington, DC, Department of Transportation.

FAA (2013). Airline Transport Pilot Certification Training Program. F. A. Administration. Washington, DC, US Department of Transportation.

FAA (2013). " Airline Transport Pilot Certification Training Program " Department of Transportation.

FAA (2013). "Part 61 Certification: Pilots, Flight Instructors, and Ground Instructors." CFR **Sec 61.23**: 1.

FAA (2013). PART 121—Operating Requirements: Domestic, Flag, and Supplemental Operations. Title 14: Aeronautics and Space. F. A. Administration. Washington, DC, Government Priniting Office.

FAA (2013). "Pilot Certification and Qualification Requirements for Air Carrier Operations." Federal Register.

FAA (2014). "Aiemen Certification System Active Pilot Summary." Retrieved 24 SEP 14, 2014, from http://registry.faa.gov/activeairmen/M70_Active_Pilots_Summary.pdf.

FAA (2014). "FAA Aerospace Forecast Fiscal Years 2014-2034." (OK 14-0723): 125.

FOCF (2013). "Families of Continental Flight 3407." Retrieved May 1, 2013, from http://www.3407memorial.com/index.php/open-action-items.

Fullerton, R. L. (2003). "An Empirical Assessment of US Air Force Pilot Attrition." Defence and Peace Economics **5**(14).

GAO (2014). "Current and Future Availability of Airline Pilots." (GAO-14-232): 61.

GAO (2014). DOD_Data_Follow_Up_Questions. Email between DoD and GAO, Government Accountability Office.

Garton, D. (2011). "Impact and Consequences of the "1500 Hour Rule" and the NPRM." American Eagle Airlines.

Greubel, D. (2013). ExpressJet Pilot Source Study. AABI Town Hall Meeting.

Hansen, M. and M. Moskowitz (2006). The Effect of Compensation on Aviator Retention. Alexandria, VA, Center for Naval Analysis**:** 84.

Harrison, B. (2013). Pilot Demand Projections/Analysis for the Next 10 Years. Audries Aircraft Analysis**:** 169.

Higgins, J., et al. (2013). An Investigation of the United States Airline Pilot Labor Supply. Grand Forks, ND, University of North Dakota, University of Nebraska Omaha, Embry-Riddle Aeronautical University, Southern Illinois University, LeTourneau University, Middle Tennessee State University**:** 35.

HQDA (2014). "“The Supply and Demand of Aviation Professionals,” and “Pilot Supply and Demand.”." Response to GAO tasker.

Lovelace, K. and J. Higgins (2011). "US Pilot Labor Supply." 35th Annual FAA Aviation Forecast Conference: 71.

Lovelace, K., et al. (2011). Pilot Labor Supply and the Role of Universities in Flight Training. A. Department. Grand Forks, ND, University of North Dakota**:** 28.

Malaud, F. (2011). Air Transport Personnel Planning. Asia Pacific Airline Training Symposium. Bangkok, International Civil Aviation Organization.

Mattock, M. and J. Arkes (2007). The Dynamic Retention Model for Air Force Officers. RAND_TR470. Santa Monica, CA, RAND Corporation**:** 85.

Maue, B. E. A. (2007). The Relationship of Activation, Pay, and Retention Among U.S. Air Force Reserve Pilots. Pardee RAND Graduate School, RAND. **PhD:** 93.

Mele, J. (2012). prior_svc_201109_accessions. A. F. P. Center. Randolph AFB, TX.

NTSB (2010). Loss of Control on Approach, Colgan Air, Inc., Operating as Continental Connection Flight 3407, Bombardier DHC-8-400, N200WQ, Clarence Center, New York, February 12, 2009. N. T. S. Board. Washington, DC, NTSB.

OPNAV (2014). Email from OPNAV 130. Aviation Data Compiled.

Robbert, A. A. (2014). Suitability of missions for the Air Force reserve components. Santa Monica, CA, RAND.

Robbert, A. A., William A Williams, Cynthia R Cook (1999). Principles for Determining the Air Force Active/Reserve Mix. Project Air Force. Santa Monica, RAND.

Smith, G., et al. (2010). "Pilot Source Study: An Analysis of Pilot Backgrounds and Subsequent Success in US Regional Airline Training Programs." International Journal of Applied Aviation Studies **10**(1): 261.

Smith, G. M. H., Derek; Bjerke, Elizabeth; Niemczyk, Mary; Nullmeyer, Robert; Paasch, Julie; and NewMyer, David A (2013). "The 2012 Pilot Source Study (Phase III): Response to the Pilot Certification and Qualification Requirements for Air Carrier Operations." Journal of Aviation Technology and Engineering **2**.

Stanley, D. W. (2012). Predicting Pilot Retention. Wright-Patterson Air Force Base, Ohio, Air Force Institute of Technology.

Sweeney, L. N. (2014). Predicting Active Duty Air Force Pilot Attrition Given an Anticipated Increase in Major Airline Pilot Hiring. Santa Monica, CA**:** 120.

United (2013). UAL Future Pilot Sourcing. AABI Winter Meeting. Auburn, AL.

USAF/A1 (2014). "AFRAMS Output 140910."

USAF/A1 and D. J. Bigelow (2014). "TFBL_NoA10_BigMAH_140724."

USG (2010). Airline Safety and Federal Aviation Administration Extension Act of 2010. Public Law 111–216. U. Government. Washington, DC, Government Publishing Office.

This product is part of the Pardee RAND Graduate School (PRGS) dissertation series. PRGS dissertations are produced by graduate fellows of the Pardee RAND Graduate School, the world's leading producer of Ph.D.s in policy analysis. The dissertation has been supervised; reviewed; and approved by the faculty committee composed of Dr. Al Robbert (Chair), Dr. Ray Conley, and Dr. Suzanne Buono.

PARDEE RAND GRADUATE SCHOOL

www.rand.org

RGSD-351